

CHAPTER 2. GENERAL CRITERIA

200. SCOPE. This chapter contains only that information common to all types of terminal instrument procedures. Criteria which do not have general application are located in the individual chapters concerned with the specific types of facilities.

201.-209. RESERVED.

Section 1. Common Information

210. UNITS OF MEASUREMENT. Units of measurement shall be expressed as set forth below:

a. Bearings, Courses, and Radials. Bearings and courses shall be expressed in degrees magnetic. Radials shall also be expressed in degrees magnetic, and shall further be identified as radials by prefixing the letter "R" to the magnetic bearing FROM the facility. For example, R-027 or R-010.

b. Altitudes. The unit of measurement for altitude in this publication is feet. Published heights below the transition level (18,000 feet) shall be expressed in feet above MSL; e.g. 17,900 feet. Published heights at and above the transition level (18,000 feet) shall be expressed as Flight Levels; e.g., FL 180, FL 190, etc.—reference FAR 91.81, Air Traffic Control Handbook 7110.65 Par. 85.

c. Distances. All distances shall be expressed in nautical miles (6076.1 feet per NM) and tenths thereof, except when applied to visibilities, which shall be expressed in statute miles and the appropriate fractions thereof. Expression of visibility values in nautical miles is permitted in overseas areas where it coincides with the host nation practice. Runway visual range (RVR) shall be expressed in feet.

d. Speeds. Aircraft speeds shall be expressed in knots.

e. Determination of Correctness of Distance and Bearing Information. The approving agency is

the authority for correctness of distance and bearing information, except that within the United States, its territories, and possessions, the National Oceanic and Atmospheric Administration is the authority for measurements between all civil navigation aids and between those facilities incorporated as part of the National Airspace System.

211. POSITIVE COURSE GUIDANCE. Positive course guidance (PCG) shall be provided for feeder routes, initial (except as provided for in paragraph 233b), intermediate, and final approach segments. The segments of a procedure wherein PCG is provided should be within the service volume of the facility(ies) used, except where Expanded Service Volume (ESV) has been authorized. PCG may be provided by one or more of the navigation systems for which criteria has been published herein.

*** 212. APPROACH CATEGORIES.** Aircraft performance differences have an effect on the airspace and visibility needed to perform certain maneuvers. Because of these differences, aircraft manufacturer/operational directives assign an alphabetical category to each aircraft so that the appropriate obstacle clearance areas and landing and departure minimums can be established in accordance with the criteria in this manual. The categories (CAT) used and referenced throughout this manual are: CAT A, B, C, D, and/or E. Aircraft categories are defined in Federal Aviation Regulations (FAR) Part 97. *

213. APPROACH CATEGORY APPLICATION.

The approach category operating characteristics shall be used to determine turning radii minimums, and obstacle clearance areas for circling and missed approach.

214. PROCEDURE CONSTRUCTION. An instrument approach procedure may have four separate segments. They are the initial, the intermediate, the final, and the missed approach segments. In addition, an area for circling the airport under visual conditions shall be considered. The approach segments begin and end at designated fixes; however, under some circumstances certain segments may begin at specified points where no fixes are available. The fixes are named to coincide with the associated segment. For example, the intermediate segment begins at the intermediate fix and ends at the final approach fix. The order in which this chapter discusses the segments is the same order in which the pilot would fly them in a completed procedure; that is from an initial, through an intermediate, to a final approach. In constructing the procedure, the final approach course should be identified first because it is the least flexible and most critical of all the segments. When the final approach has been determined, the other segments should be blended with it to produce an orderly maneuvering pattern which is responsive to the local traffic flow. Consideration shall also be given to any accompanying controlled airspace requirements in order to conserve airspace to the extent it is feasible. See Figure 1.

215. CONTROLLING OBSTACLE(S). The controlling obstacle in the primary area of the final approach segment shall be identified in procedures submitted for publication.

216.-219. RESERVED.

Section 2. En route Operations

220. FEEDER ROUTES. When the initial approach fix is part of the en route structure there may be no need to designate additional routes for aircraft to proceed to the initial approach fix (IAF). In some cases, however, it is necessary to designate feeder routes from the en route structure to the initial approach fix. Only those feeder routes which provide an operational advantage shall be established and published. These should coincide

with the local air traffic flow. The length of the feeder route shall not exceed the operational service volume of the facilities which provide navigational guidance unless additional frequency protection is provided. En route airway obstacle clearance criteria shall apply to feeder routes. The minimum altitude established on feeder routes shall not be less than the altitude established at the IAF.

221. MINIMUM SAFE ALTITUDES. A minimum safe altitude is the minimum altitude which provides at least 1,000 feet of obstacle clearance for emergency use within a specified distance from the navigation facility upon which a procedure is predicated. These altitudes will be rounded to the next higher 100-foot increment. Such altitudes will be identified as minimum sector altitudes or emergency safe altitudes and shall be established as follows:

a. Minimum Sector Altitudes. Minimum sector altitudes shall be established for all procedures within a 25-mile radius of the navigational facility. When the distance from the primary facility to the airport exceeds 25 miles the radius shall be expanded to include the airport landing surfaces up to a maximum distance of 30 miles. When the procedure does not use an omnidirectional facility (LOC BC with a fix for the FAF), the primary omnidirectional facility in the area will be used. A common safe altitude may be established for the entire area around the facility or sector altitudes may be established to offer relief from obstacles. Sectors shall not be less than 90° in spread. Sector altitudes may be raised and combined with adjacent higher sectors when a height difference does not exceed 300 feet. The sector altitude established shall also provide 1,000 feet of obstacle clearance in the adjacent sector or periphery area within four miles of the sector division or the periphery boundary line. See Figure 2.

b. Emergency Safe Altitudes. Emergency safe altitudes shall be established with a 100-mile radius of the navigation facility at the option of the approving authority. They are normally used only in military procedures. Where a requirement exists for these altitudes, they shall be established with a common altitude for the entire area. Where these

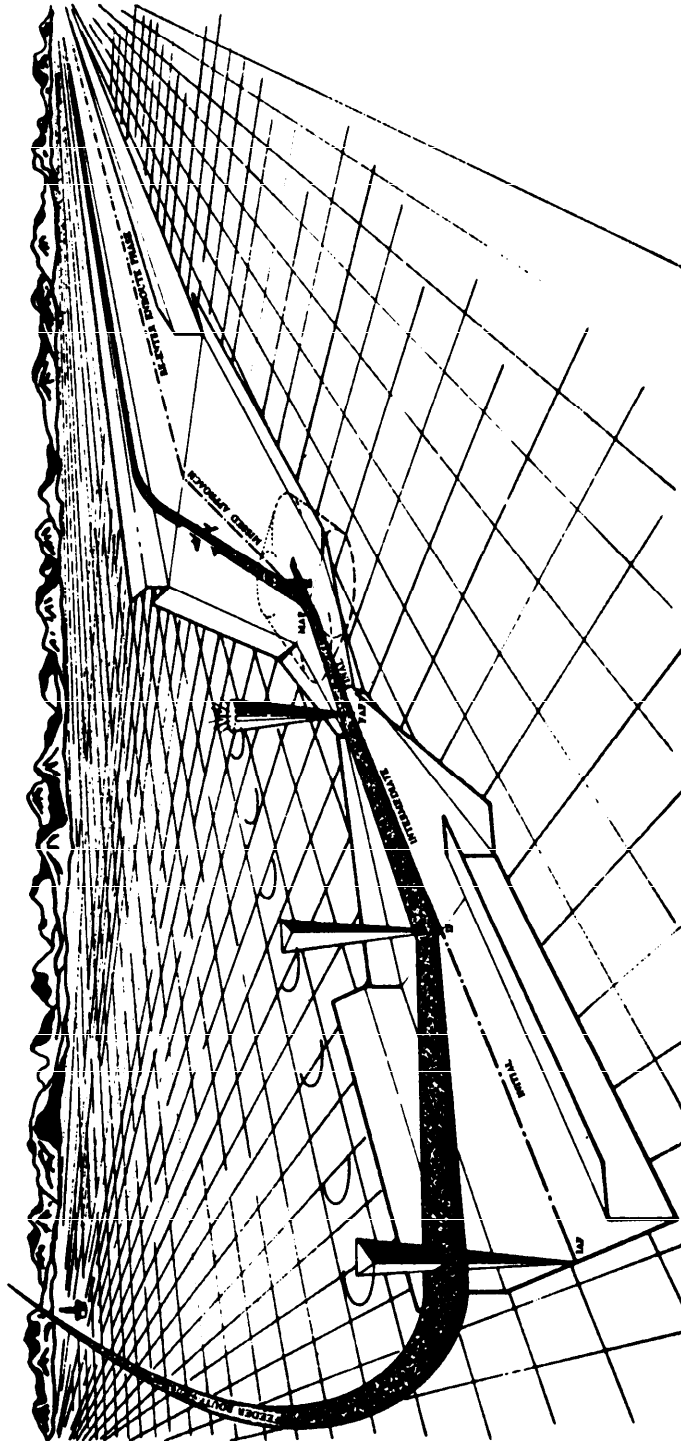


Figure 1. SEGMENTS OF AN APPROACH PROCEDURE. Pp. 214.

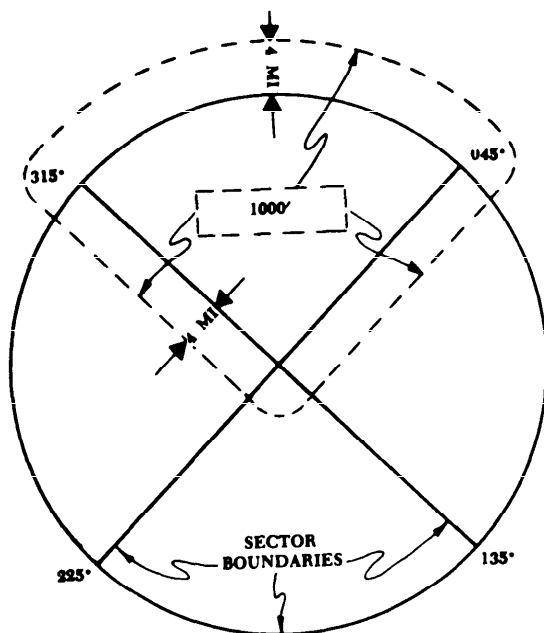


Figure 2. MINIMUM SECTOR ALTITUDES. Par 221.

altitudes are established in designated mountainous areas, they shall provide 2000 feet of obstacle clearance. These altitudes shall be identified on published procedures as "emergency safe altitudes".

222. - 229. RESERVED.

Section 3. Initial Approach

230. INITIAL APPROACH SEGMENT. The instrument approach commences at the Initial Approach Fix (IAF). In the initial approach the aircraft has departed the enroute phase of flight, and is maneuvering to enter an intermediate segment. When the intermediate fix is part of the enroute structure, it may not be necessary to designate an initial approach segment. In this case the approach commences at the intermediate fix and intermediate segment criteria apply. An initial approach may be

made along an arc, radial, course, heading, radar vector, or a combination thereof. Procedure turns, holding pattern descents, and high altitude penetrations are initial segments. Positive course guidance is required except when dead reckoning courses can be established over limited distances. Although more than one initial approach may be established for a procedure, the number should be limited to that which is justified by traffic flow or other operational requirements. Where holding is required prior to entering the initial approach segment, the holding fix and initial approach fix should coincide. When this is not possible the initial approach fix shall be located within the holding pattern on the inbound holding course.

231. ALTITUDE SELECTION. Minimum altitudes in the initial approach segment shall be established in 100-foot increments; i.e., 1549 feet may be shown as 1500 feet and 1550 feet shall be shown as 1600. The altitude selected shall not be below the procedure turn altitude where a procedure turn is required. In addition, altitudes specified in the initial approach segment must not be lower than any altitude specified for any portion of the intermediate or final approach segment.

232. INITIAL APPROACH SEGMENTS BASED ON STRAIGHT COURSES AND ARCS WITH POSITIVE COURSE GUIDANCE.

a. Alignment.

(1) **Courses.** The angle of intersection between the initial approach course and the intermediate course shall not exceed 120 degrees. When the angle exceeds 90 degrees, a radial or bearing which provides at least 2 miles of lead shall be identified to assist in leading the turn onto the intermediate course. See Figure 3.

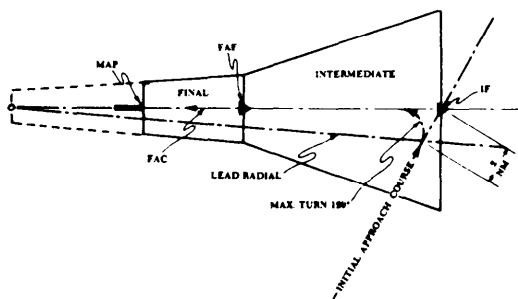


Figure 3. INITIAL APPROACH INTERCEPTION ANGLE GREATER THAN 90 DEGREES. Par 232.a.(1)

(2) **Arcs.** An arc may provide course guidance for all or a portion of an initial approach. The minimum arc radius shall be 7 miles, except for high altitude jet penetration procedures, in which the minimum radius should be at least 15 miles. When an arc of less than 15 miles is used in high altitude procedures, the descent gradient along the arc shall not exceed the values in table 1. An arc may join a course at or before the intermediate fix. When joining a course at or before the intermediate fix, the angle of intersection of the arc and the course shall not exceed 120°. When the angle exceeds 90°, a radial which provides at least 2 miles of lead shall be identified to assist in leading the turn onto the intermediate course. DME arc courses shall be predicated on DME collocated with a facility providing omnidirectional course information.

Table 1. DESCENT GRADIENT ON AN ARC.

MILES	MAX FT. PER NM
15	1,000
14	720
13	640
12	560
11	480
10	400
9	320
8	240
7	160

b. Area. The initial approach segment has no standard length. The length shall be sufficient to permit the altitude change required by the procedure and shall not exceed 50 miles unless an operational requirement exists. The total width of the initial approach segment shall be 6 miles on each side of the initial approach course. This width is divided into a primary area, which extends laterally 4 miles on each side of the course, and a secondary area, which extends laterally 2 miles on each side of the primary area. See figure 10. When any portion of the initial approach is more than 50 miles from the navigation facility, the criteria for en route airways shall apply to that portion.

c. Obstacle Clearance. The obstacle clearance in the initial approach primary area shall be a minimum of 1,000 feet. In the secondary area 500 feet of obstacle clearance shall be provided at the inner edge, tapering uniformly to zero feet at the outer edge. The minimum obstacle clearance required at any given point in the secondary area is shown in Appendix 2, figure 123. Allowance for precipitous terrain should be made as specified in paragraph 323a. The altitudes selected by application of the obstacle clearance specified in this paragraph may be rounded to the nearest 100 feet. See paragraph 231.

d. Descent Gradient. The OPTIMUM descent gradient in the initial approach is 250 feet per mile. Where a higher descent gradient is necessary, the MAXIMUM permissible gradient is 500 feet per mile. The OPTIMUM descent gradient for high altitude penetrations is 800 feet per mile. Where a higher descent gradient is necessary, the MAXIMUM permissible gradient is 1,000 feet per mile.

233. INITIAL APPROACH SEGMENT BASED ON DEAD RECKONING (DR). See ILS Chapter for special limitations.

a. Alignment. Each DR course shall intercept the extended intermediate course. For LOW altitude procedures, the intercept point shall be at least 1 mile from the intermediate fix (IF) for each 2 miles of DR flown. For HIGH altitude procedures, the intercept point may be 1 mile for each 3 miles of DR flown. The intercept angle shall:

(1) Not exceed 90°.

(2) Not be less than 45° except when DME is used OR the DR distance is 3 miles or less.

b. Area. The MAXIMUM length of the DR portion of the initial segment is 10 miles (except paragraph 232b applies for HIGH altitude procedures where DME is available throughout the DR segment). Where the DR course begins, the width is 6 miles on each side of the course, expanding by 15° outward until joining the points shown in figures 4A, 4B, 4C, 4D, and 4E.

c. Obstacle Clearance. The obstacle clearance in the DR initial approach segment shall be a minimum of 1,000 feet. There is no secondary area. Allowance for precipitous terrain should be considered as specified in paragraph 323a. The altitudes selected by application of the obstacle clearance specified in this paragraph may be rounded to the nearest 100 feet. See paragraph 231.

d. Descent Gradient. The OPTIMUM descent gradient in the initial approach is 250 feet per mile. Where a higher descent gradient is necessary, the MAXIMUM permissible gradient is 500 feet per mile. The OPTIMUM descent gradient for high altitude penetrations is 800 feet per mile. Where a higher descent gradient is necessary, the MAXIMUM permissible gradient is 1,000 feet per mile.

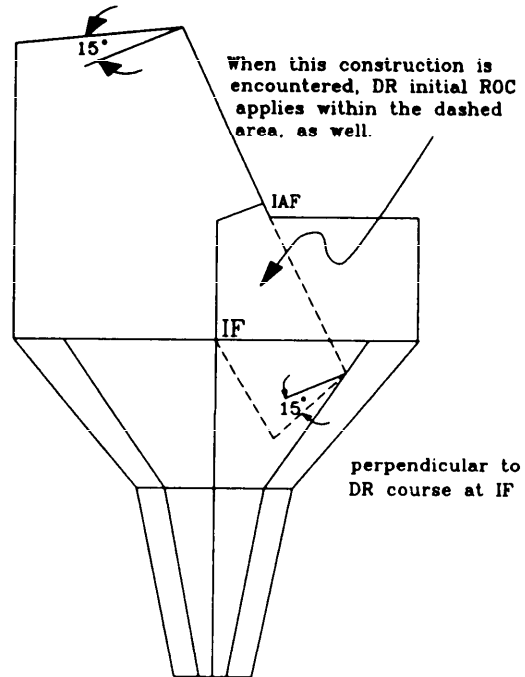


Figure 4B. DR SEGMENT WITH BOUNDARY INSIDE THE INTERMEDIATE SEGMENT. Paragraph 233b.

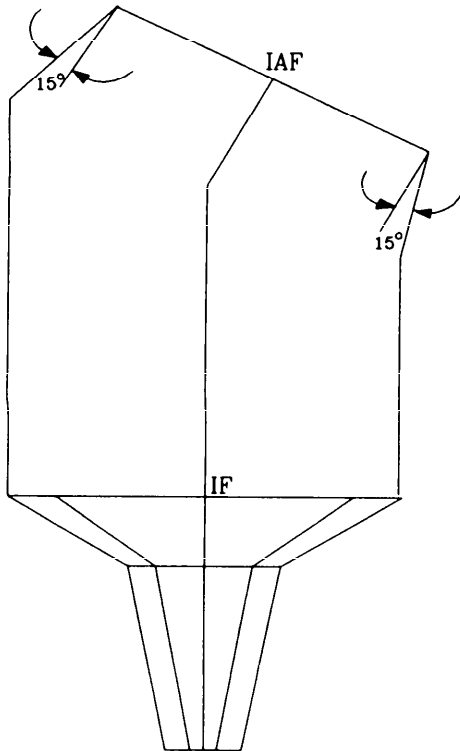


Figure 4A. MOST COMMON DR SEGMENT. Paragraph 233b.

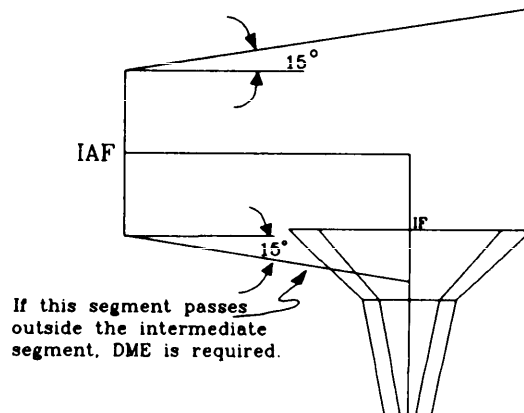


Figure 4C. DR SEGMENT WITH BOUNDARY INTERCEPTING THE INTERMEDIATE SEGMENT. Paragraph 233b.

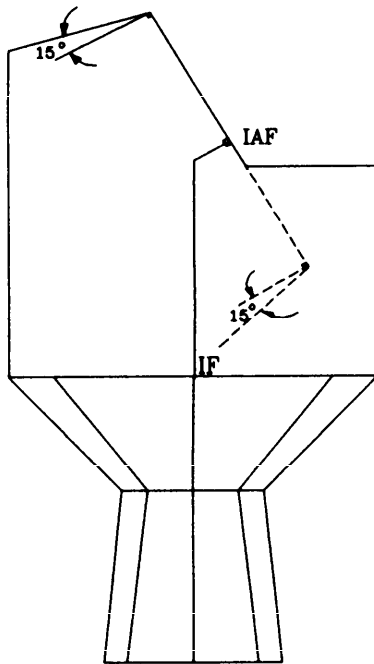


Figure 4D. DR INITIAL SEGMENT WITH BOUNDARY INSIDE THE STRAIGHT INITIAL SEGMENT. Paragraph 233b.

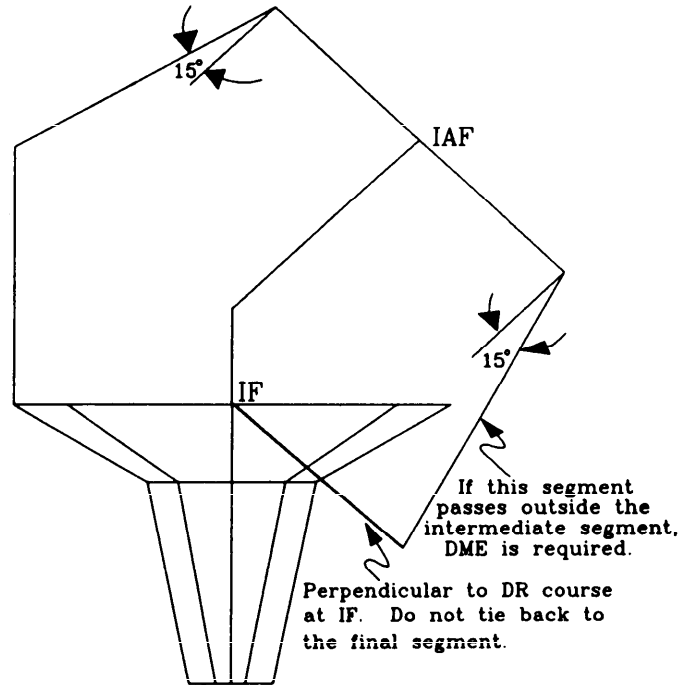


Figure 4E. DR INITIAL SEGMENT WITH BOUNDARY OUTSIDE THE INTERMEDIATE SEGMENT. Paragraph 233b.

234. INITIAL APPROACH SEGMENT BASED ON A PROCEDURE TURN. A procedure turn shall be specified when it is necessary to reverse direction to establish the aircraft on an intermediate or final approach course, except as specified in paragraph 234e. A procedure turn begins by overheading a facility or fix which meets the criteria for a holding fix (see paragraph 287b), or for a final approach fix (see paragraph 287c). The procedure shall specify the procedure turn fix, the outbound and inbound course, the distance within which the procedure turn shall be completed, and the direction of the procedure turn. When a teardrop turn is used, the angle of divergence between the outbound course and the reciprocal of the inbound course shall be MINIMUM of 15° or a MAXIMUM of 30° (see paragraph 235a for high altitude teardrop penetrations). In all procedure turns, the degree of turn and the point at which the turn is begun are left to the discretion of the pilot. However, the maneuver shall be completed within the procedure turn area, and not below the altitude specified for its completion. When no fix marks the beginning of the intermediate or final approach segment associated with the procedure turn, these segments are deemed to commence on the inbound procedure turn course at the maximum distance specified in the procedure.

a. Alignment. When the inbound course of the procedure turn becomes the intermediate course it must meet the intermediate course alignment criteria (see paragraph 242a). When the inbound course becomes the final approach course it must meet the final approach course alignment criteria (see paragraph 250). The wider side of the procedure turn area shall be oriented in the same direction as that prescribed for the procedure turn.

b. Area. The procedure turn areas are depicted in Figure 5. The normal procedure turn distance is 10 miles. This distance may be decreased to 5 miles where only Approach Category "A" aircraft are to be operated and may be increased to as much as 15 miles or as specified in paragraph 234d. When a procedure turn is authorized for use by Approach Category "E" aircraft a 15-mile procedure turn distance shall be used. The procedure turn segment is divided into zones and areas. They are the Entry Zone, the Maneuvering Zone, the Primary Area, and the Secondary Area. See Figure 5. As shown, the entry zone is the zone in which entry is made into the maneuvering zone. Its inner boundary extends perpendicular to the

inbound course at the procedure turn fix. The remainder of the procedure turn segment is the maneuvering zone.

NORMAL PROCEDURE TURN AREA

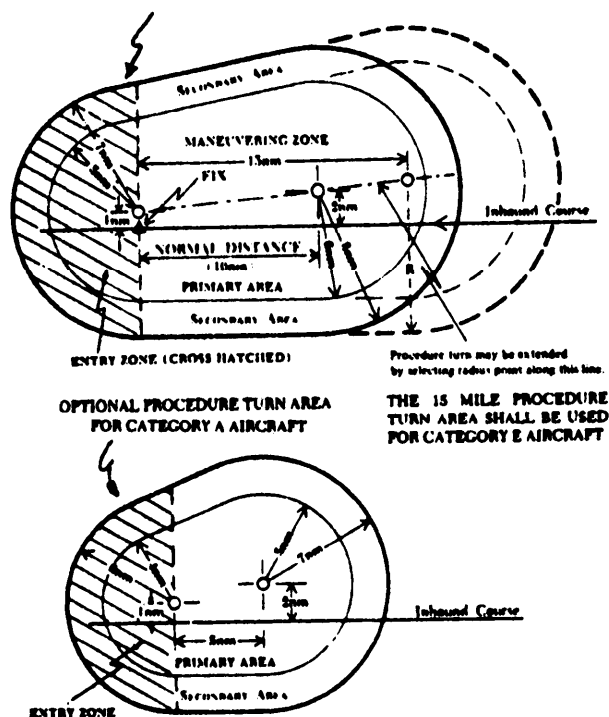


Figure 5. PROCEDURE TURN AREAS. Par 234.b.

c. Obstacle Clearance. A minimum of 1,000 feet of clearance shall be provided in the primary area. In the secondary area, 500 feet of obstacle clearance shall be provided at the inner edge, tapering uniformly to zero feet at the outer edge. The minimum obstacle clearance required at any given point in the secondary area is shown in the graph in Appendix 2, Figure 123. Allowance for precipitous terrain should be considered as specified in paragraph 323a. The primary and secondary areas determine obstacle clearance in both the entry and maneuvering zones. The use of entry and maneuvering zones provides further relief from obstacles. The entry zone is established to control the obstacle clearance UNTIL proceeding outbound from the procedure turn fix. The maneuvering zone is established to control obstacle clearance AFTER proceeding outbound from the procedure turn fix. See Figure 6. The altitudes selected by application of the obstacle clearance specified in this paragraph may be rounded to the nearest 100 feet (see paragraph 231).

d. *Descent Gradient.* The OPTIMUM descent gradient in the initial approach is 250 feet per mile. Where a higher descent gradient is necessary, the MAXIMUM permissible gradient is 500 feet per mile. The procedure turn completion altitude should be as close as possible to the final approach fix altitude. The difference between the procedure turn completion altitude and the altitude over the final approach fix shall not be greater than those shown in table 1A. If greater differences are required for a 5 or 10-mile procedure turn, the procedure turn distance limits and maneuvering zone shall be increased at the rate of 1 mile for each 200 feet of required altitude. No extension of the procedure turn is permitted without a final approach fix.

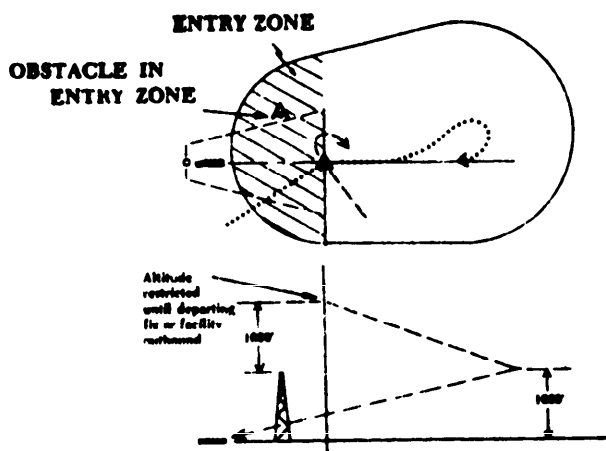


Figure 6. PROCEDURE TURN INITIAL APPROACH AREA. Par 234c.

e. *Elimination of Procedure Turn.* A procedure turn is NOT required when an approach can be made direct from a specified intermediate fix to the final approach fix. A procedure turn NEED NOT be established when an approach can be made from a properly aligned holding pattern. See paragraph 291. In this case, the holding pattern shall be established over a final or intermediate approach fix and the following conditions apply:

(1) If the holding pattern is established over the final approach fix, the minimum holding altitude shall be not more than 300 feet above the altitude specified for crossing the final approach fix inbound.

(2) If the holding pattern is established over the intermediate fix, the minimum holding altitude shall permit descent to the final approach fix altitude within the descent gradient tolerances prescribed for the intermediate segment. See paragraph 243d.

Table 1A. PROCEDURE TURN COMPLETION ALTITUDE DIFFERENCE

TYPE OF PROCEDURE TURN	ALTITUDE DIFFERENCE
15 Mile PT from FAF	Within 3000 Ft of Alt. over FAF
10 Mile PT from FAF	Within 2000 Ft of Alt. over FAF
5 Mile PT from FAF	Within 1000 Ft of Alt. over FAF
15 Mile PT, no FAF	Not Authorized.
10 Mile PT, no FAF	Within 1500 Ft of MDA on Final
5 Mile PT, no FAF	Within 1000 Ft of MDA on Final

235. INITIAL APPROACH BASED ON HIGH ALTITUDE TEARDROP PENETRATION.

A teardrop penetration consists of departure from an initial approach fix on an outbound course, followed by a turn toward and intercepting the inbound course at or prior to the intermediate fix or point. Its purpose is to permit an aircraft to reverse direction and lose considerable altitude within reasonably limited airspace. Where no fix is available to mark the beginning of the intermediate segment, it shall be assumed to commence at a point 10 miles prior to the final approach fix. When the facility is located on the airport, and no fix is available to mark the beginning of the final approach segment, the criteria in paragraph 423 apply.

a. *Alignment.* The outbound penetration course shall be between 18 and 20 degrees to the left or right of the reciprocal of the inbound course. The actual angular divergence between the courses will vary inversely with the distance from the facility at which the turn is made. See table 2.

b. *Area.*

(1) *Size.* The size of the penetration turn area must be sufficient to accommodate both the turn and the altitude loss required by the procedure. The penetration turn distance shall not be less than 20 miles from the facility. The penetration turn distance depends on the altitude to be lost in the

Table 2. PENETRATION TURN DISTANCE/
DIVERGENCE.

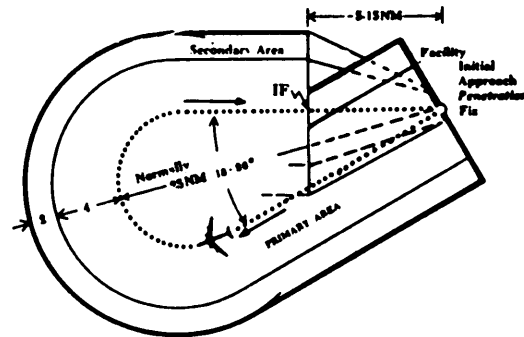
ALT TO BE LOST PRIOR TO COM- MENCING TURN	DISTANCE TURN COM- MENCES (NM)	COURSE DIVER- GENCE (DE- GREES)	SPECIFIED PENETRATION TURN DIS- TANCE (NM)
12,000 Ft	24	18	28
11,000 Ft	23	19	27
10,000 Ft	22	20	26
9,000 Ft	21	21	25
8,000 Ft	20	22	24
7,000 Ft	19	23	23
6,000 Ft	18	24	22
5,000 Ft	17	25	21
5,000 Ft	16	26	20

procedure and the point at which the descent is started. See Table 2. The aircraft should lose half the total altitude or 5000 feet, whichever is greater, outbound prior to starting the turn. The penetration turn area has a width of 6 miles on both sides of the flight track up to the intermediate fix or point, and shall encompass all the areas within the turn. See Figure 8.

(2) **Penetration Turn Table.** Table 2 should be used to compute the desired course divergence and penetration turn distances which apply when a specific altitude loss outbound is required. It is assumed that the descent begins immediately upon station passage. When the procedure requires a delay before descent of more than 5 miles, the distance in excess of 5 miles should be added to the distance the turn commences. The course divergence and penetration turn distance should then be adjusted to correspond to the adjusted turn distance. Extrapolations may be made from the table.

(3) **Primary and Secondary Areas.** All of the penetration turn is primary area except the outer 2 miles of the 6-mile obstacle clearance area on the outer side of the penetration track. See Figure 8. The outer 2 miles is secondary area. The outer 2 miles on both sides of the inbound penetration course should be treated as secondary area.

c. Obstacle Clearance. Obstacle clearance in the initial approach primary area shall be a MINIMUM of 1,000 feet. Obstacle clearance at the

Figure 8. TYPICAL PENETRATION TURN INITIAL
APPROACH AREA. Par 235.

inner edge of the secondary area shall be 500 feet, tapering to zero feet at the outer edge. The minimum obstacle clearance at any given point in the secondary area is found by using the graph in Appendix 2, Figure 123. Where no intermediate fix is available, a 10 NM intermediate segment is assumed and normal obstacle clearance is applied to the controlling obstacle. The controlling obstacle, as well as the minimum altitude selected for the intermediate segment, may depend on the availability of an intermediate fix. See Figure 9. Allowance for precipitous terrain should be considered in the penetration turn area as specified in paragraph 323a. The altitudes selected by application of the obstacle clearance specified in this paragraph may be rounded to the nearest 100 feet. See paragraph 231.

d. Descent Gradient. The procedure should be based on an OPTIMUM descent gradient of 800 feet per mile. Where a higher descent gradient is necessary, the MAXIMUM permissible gradient is 1,000 feet per mile.

e. Penetration Turn Altitude. When an intermediate fix is NOT provided, the penetration turn completion altitude shall not be more than 4,000 feet above the final approach fix altitude.

* 236. INITIAL APPROACH COURSE REVERSAL USING NONCOLLOCATED FACILITIES AND A TURN OF 120 DEGREES OR GREATER TO INTERCEPT THE INBOUND COURSE. See Figure 8A. *

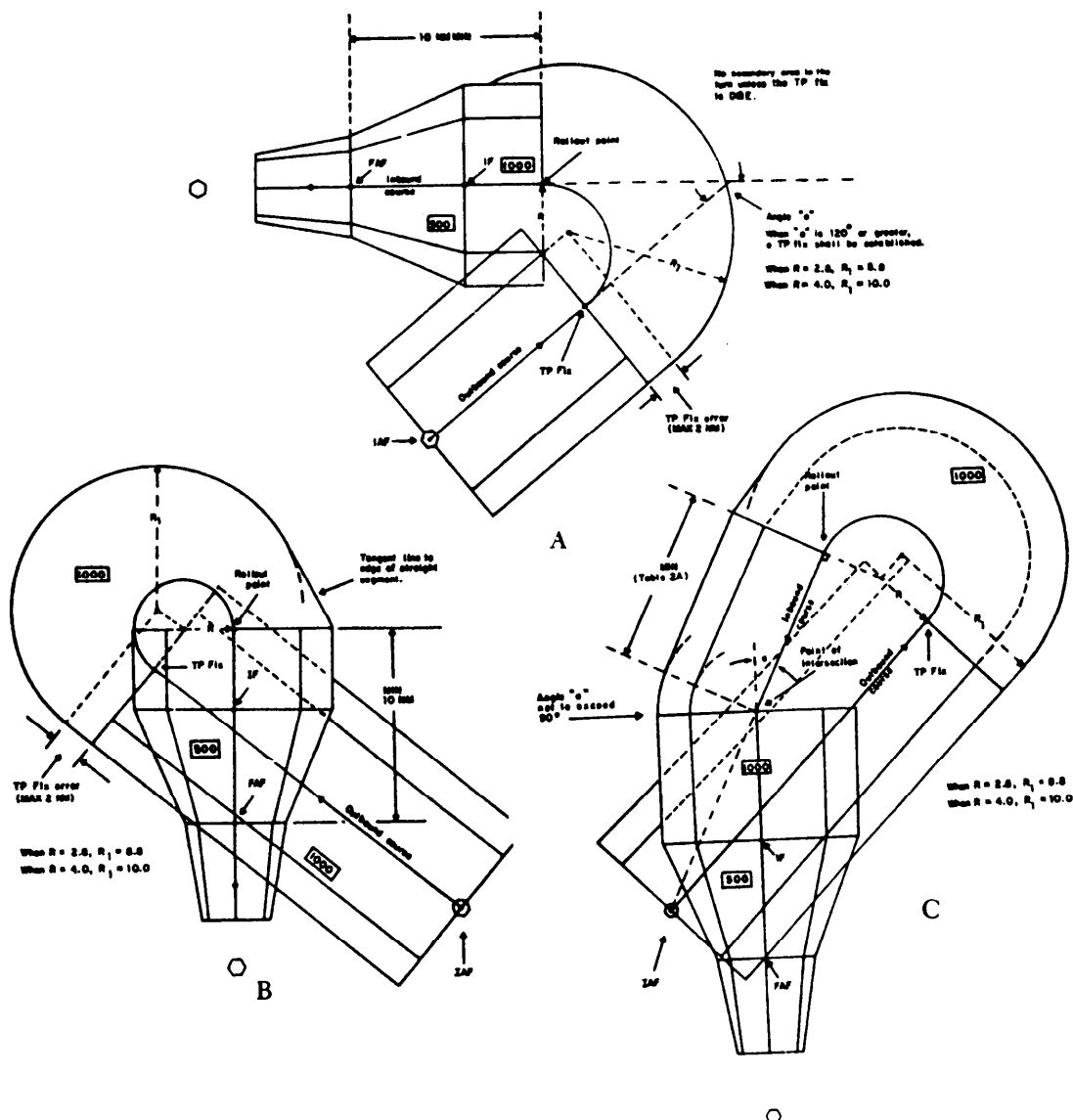


Figure 8A. EXAMPLES OF INITIAL APPROACH COURSE REVERSAL. Par 236.

a. Common Criteria.

(1) A turn point (TP) fix shall be established as shown in the figures. The fix error shall meet section 8 criteria, and shall not exceed ± 2 NM.

(2) A flightpath radius of 2.8 NM shall be used for procedures where the altitude at the TP fix

is 10,000 feet MSL or below, or 4 NM for procedures where the altitude at the TP fix is above 10,000 feet MSL.

(3) **Descent Gradient.** Paragraph 232d applies.

(4) **Obstacle Clearance.** Paragraph 235c applies.

(5) **Initial Distance.** When the course reversal turn intercepts the extended intermediate course, and when the course reversal turn intercepts a straight segment prior to intercepting the extended intermediate course, the minimum distance between the rollout point and the FAF is 10 NM.

(6) **ROC Reduction.** No reduction of secondary ROC is authorized in the course reversal area unless the TP fix is DME.

b. Figure 8A (A and B). The rollout point shall be at or prior to the intermediate fix/point.

(1) Select the desired rollout point on the inbound course.

(2) Place the appropriate flightpath arc tangent to the rollout point.

(3) From the outbound facility, place the outbound course tangent to the flightpath arc. The point of tangency shall be the TP fix.

c. Figure 8A(C).

(1) The point of intersection shall be at or prior to the intermediate fix/point (paragraph 242 applies). The angle shall be 90° or less.

(2) The distance between the rollout point and the point of intersection shall be no less than the distance shown in Table 2A.

(3) Paragraph 235 and Table 2 should be used for high altitude procedures up to the point of intersection of the two inbound courses.

TABLE 2A	MINIMUM DISTANCE FROM ROLLOUT POINT TO POINT OF INTERSECTION
ANGLE "a"	
0° - 15°	1 NM
16° - 30°	2 NM
31° - 45°	3 NM
46° - 60°	4 NM
61° - 75°	5 NM
76° - 90°	6 NM

(4) Select the desired point of intersection. From the outbound facility draw a line through the point of intersection.

(5) At the outbound facility measure the required number of degrees course divergence (may be either side of the line through the point of intersection) and draw the outbound course out the required distance. Connect the outbound course and the line through the point of intersection with the appropriate arc.

(6) Determine the desired rollout point on the line through the point of intersection.

(a) Place the appropriate flight path arc tangent to the rollout point.

(b) From the outbound facility draw the outbound course tangent to the flight path arc. The point of tangency is the TP fix.

237.-239. RESERVED.

Section 4. Intermediate Approaches

240. INTERMEDIATE APPROACH SEGMENT.

This is the segment which blends the initial approach segment into the final approach segment. It is the segment in which aircraft configuration, speed, and positioning adjustments are made for entry into the final approach segment. The intermediate segment begins at the intermediate fix (IF), or point, and ends at the final approach fix (FAF). There are two types of intermediate segments; the "radial" or "course" intermediate segment and the "arc" intermediate segment. In either case, positive course guidance shall be provided. See Figure 10 for typical approach segments.

241. **ALTITUDE SELECTION.** The MINIMUM altitude in the intermediate segment shall be established in 100-foot increments; i.e., 749 feet may be shown as 700 feet and 750 feet shall be shown as 800. In addition, the altitude selected for arrival over the FAF shall be low enough to permit descent from the FAF to the airport for a straight-in landing whenever possible.

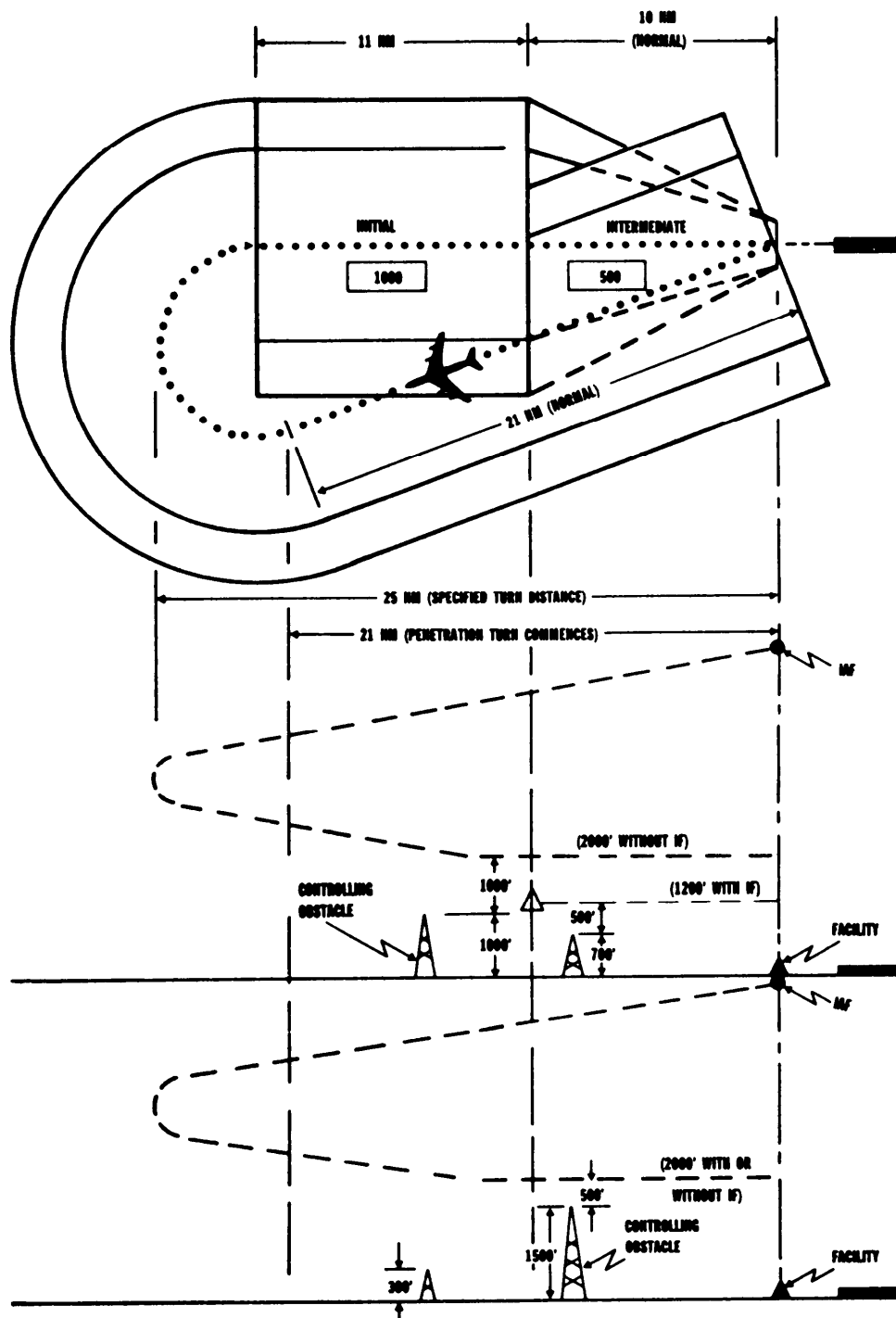


Figure 9. PENETRATION TURN INITIAL APPROACH OBSTACLE CLEARANCE. Par 235.

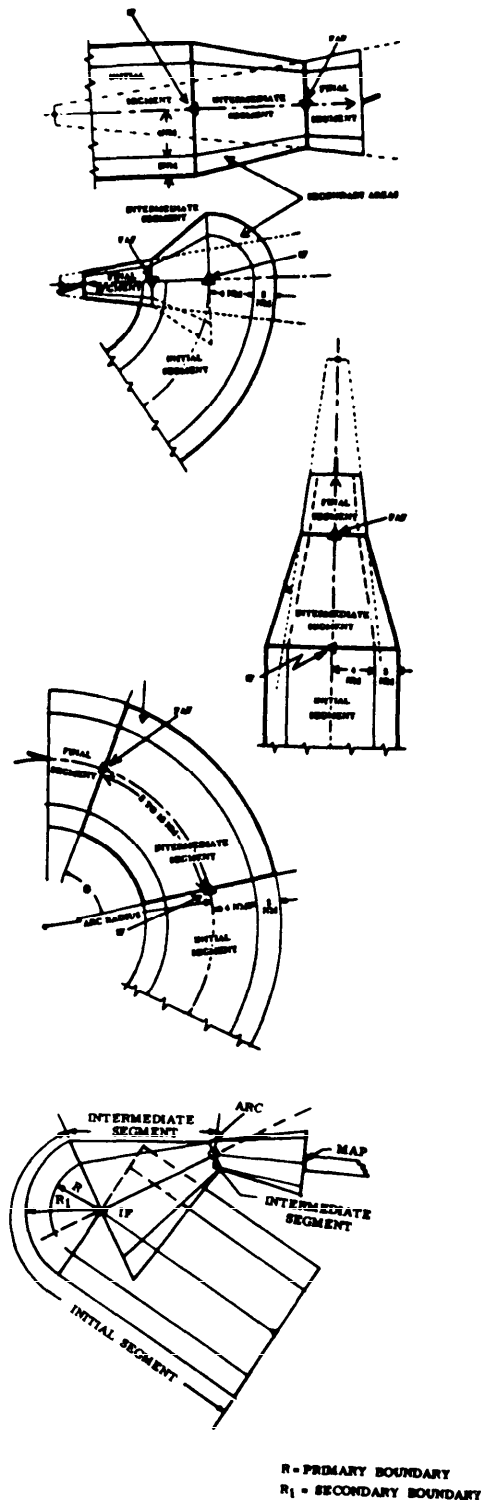


Figure 10. TYPICAL APPROACH SEGMENTS.
Par 230., 232.b., and 240

242. INTERMEDIATE APPROACH SEGMENT BASED ON STRAIGHT COURSES.

a. Alignment. The course to be flown in the intermediate segment shall be the same as the final approach course, except when the final approach fix is the navigation facility and it is not practical for the courses to be identical. In such cases, the intermediate course shall not differ from the final approach course by more than 30 degrees.

b. Area.

(1) **Length.** The intermediate segment shall not be less than 5 miles (except as provided for in Chapters 9 & 10) nor more than 15 miles in length, measured along the course to be flown. The OPTIMUM length is 10 miles. A distance greater than 10 miles should not be used unless an operational requirement justifies a greater distance. When the angle at which the initial approach course joins the intermediate course exceeds 90 degrees (See Figure 3.) the MINIMUM length of the intermediate course is as shown in Table 3.

(2) **Width.** The width of the intermediate segment is the same as the width of the segment it joins. When the intermediate segment is aligned with initial or final approach segments, the width of the intermediate segment is determined by joining the outer edges of the initial segment with the outer edges of the final segment. When the intermediate segment is not aligned with the initial or final approach segments, the resulting gap on the outside of the turn is a part of the preceding segment and is closed by the appropriate arc. See Figure 10. For obstacle clearance purposes, the intermediate segment is divided into a primary and a secondary area. The width of the secondary area at any given point may be determined by using the graph shown in Appendix 2, Figure 122.

Table 3. MINIMUM INTERMEDIATE COURSE LENGTH.
Par 242.b.(1)

ANGLE (DEGREES)	MINIMUM LENGTH (MILES)
91 - 96	6
97 - 102	7
103 - 108	8
109 - 114	9
115 - 120	10

c. *Obstacle Clearance.* A MINIMUM of 500 feet of obstacle clearance shall be provided in the primary area of the intermediate approach segment. In the secondary area, 500 feet of obstacle clearance shall be provided at the inner edge, tapering to zero feet at the outer edge. The minimum obstacle clearance required at any given point in the secondary area may be determined by using the graph in Appendix 2, Figure 123. Allowance for precipitous terrain should be considered as specified in Paragraph 323.a. The altitudes selected by application of the obstacle clearance specified in this paragraph may be rounded to the nearest 100 feet. See Paragraph 241.

d. *Descent Gradients.* Because the intermediate segment is used to prepare the aircraft speed and configuration for entry into the final approach segment, the gradient should be as flat as possible. The OPTIMUM descent gradient in this area should not exceed 150 feet per mile. Where a higher descent gradient is necessary, the MAXIMUM permissible gradient is 300 feet per mile except for a localizer approach published in conjunction with an ILS procedure. In this case, a higher descent gradient equal to the commissioned glide slope angle (provided it does not exceed 3°) is permissible. Higher gradients resulting from arithmetic rounding are also permissible.

NOTE: When the descent gradient exceeds 300 feet per mile, the procedure specialist should assure a segment is provided prior to the intermediate segment to prepare the aircraft speed and configuration for entry into the final segment. This segment should be a minimum length of 5 miles and its descent gradient should not exceed 300 feet per mile.

243. INTERMEDIATE APPROACH SEGMENT BASED ON AN ARC. Arcs with a radius of less than 7 miles or more than 30 miles from the navigation facility shall NOT be used. DME arc courses shall be predicated on DME collocated with a facility providing omnidirectional course information.

a. *Alignment.* The same arc shall be used for the intermediate and the final approach segments. No turns shall be required over the final approach fix.

b. *Area.*

(1) *Length.* The intermediate segment shall NOT be less than 5 miles nor more than 15 miles in length, measured along the arc. The OPTIMUM length is 10 miles. A distance greater than 10 miles should not be used unless an operational requirement justifies the greater distance.

(2) *Width.* The total width of an arc intermediate segment is 6 miles on each side of the arc. For obstacle clearance purposes, this width is divided into a primary and a secondary area. The primary area extends 4 miles laterally on each side of the arc segment. The secondary areas extend 2 miles laterally on each side of the primary area. See Figure 10.

c. *Obstacle Clearance.* A MINIMUM of 500 feet of obstacle clearance shall be provided in the primary area. In the secondary area, 500 feet of obstacle clearance shall be provided at the inner edge, tapering to zero feet at the outer edge. The minimum obstacle clearance required at any given point in the secondary area may be determined by using the graph in Appendix 2, Figure 123. Allowance for precipitous terrain should be considered as specified in paragraph 323a. The altitudes selected by application of the obstacle clearance specified in this paragraph may be rounded to the nearest 100 feet. See paragraph 241.

d. *Descent Gradients.* Criteria specified in paragraph 242d shall apply.

244. INTERMEDIATE APPROACH SEGMENT WITHIN A PROCEDURE TURN (PT).

a. *PT Over a FAF* When the FAF is a Facility. See Figure 11.

(1) The MAXIMUM intermediate length is 15 nautical miles (NM), the OPTIMUM is 10 NM, and the MINIMUM is 5 NM. Its width is the same as the final segment at the facility and expand uniformly to 6 NM on each side of the course at 15 NM from the facility.

(2) The intermediate segment considered for obstacle clearance shall be the same length as the PT distance, e.g., if the procedure requires a PT to be completed within 5 NM, the intermediate segment shall be only 5 NM long, and the intermediate approach shall begin on the intermediate course 5 NM from the FAF.

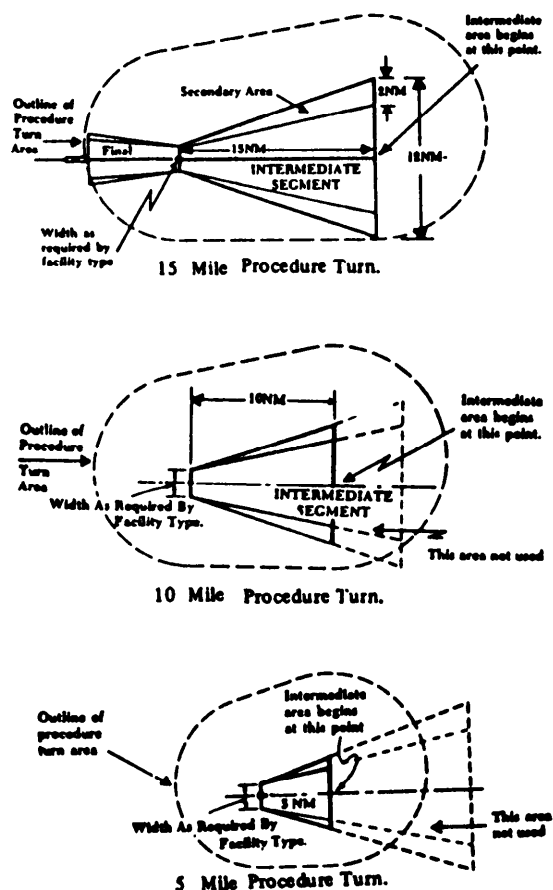


Figure 11. INTERMEDIATE AREA WITHIN A PROCEDURE TURN AREA. FAF is the Facility. Par 244.a.

b. PT Over a FAF When the FAF is NOT a Facility. See Figure 12. The intermediate segment shall be 6 NM wide each side of the intermediate course at the PT distance.

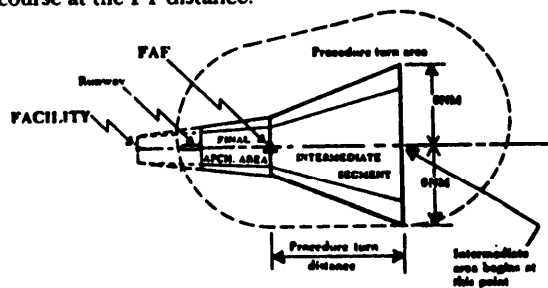


Figure 12. INTERMEDIATE AREA WITHIN THE PROCEDURE TURN AREA. FAF is NOT the Facility. Par 244.b.

c. PT Over a Facility/Fix AFTER the FAF. See Figure 13.

(1) The PT facility/fix to FAF distance shall not exceed 4 NM.

(2) The MAXIMUM PT distance is 15 NM.

(3) The length of the intermediate segment is from the start of the PT distance to the FAF and the MINIMUM length shall be 5 NM.

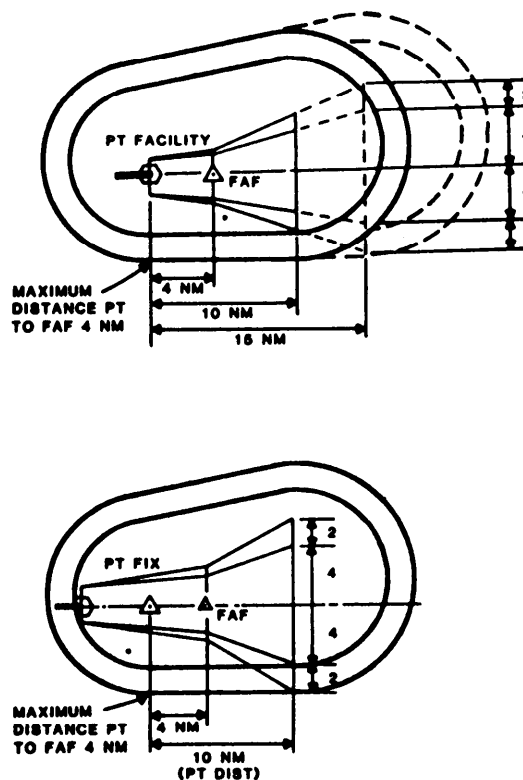


Figure 13. INTERMEDIATE AREA WITHIN THE PROCEDURE TURN AREA. PT Over the Facility/Fix After the FAF. Par 244c.

(4) Intermediate Segment Area.

(a) PT Over a Facility. The intermediate segment starts 15 NM from the facility at a width of 8 NM each side of the inbound course and connects to the width of the final segment at the FAF. The area considered for obstacle clearance is from the start of the PT distance to the FAF.

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(b) *PT Over a Fix (NOT a Facility)*. The intermediate segment starts at the PT distance at a width of 6 NM each side of the inbound course and connects to the width of the final segment at the FAF. The area considered for obstacle clearance is from the start of the PT distance to the FAF.

(5) The MAXIMUM descent gradient in the intermediate segment is 200 feet/NM. The PT distance may be increased in 1 NM increments up to 15 NM to meet descent limitations.

d. *PT Over a Facility/Fix PRIOR to the FAF*. See Figures 14 and 14A.

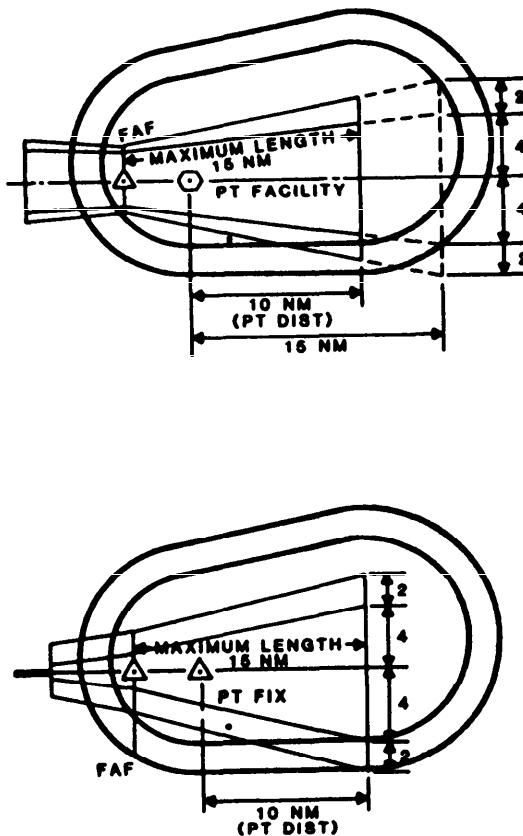


Figure 14. INTERMEDIATE AREA WITHIN THE PROCEDURE TURN AREA. PT Over the Facility/Fix Prior to the FAF. Par 244d.

(1) The MINIMUM PT distance is 5 NM.

(2) The length of the intermediate segment is from the start of the PT distance to the FAF and the MAXIMUM length is 15 NM.

(3) Intermediate Segment Area.

(a) *PT Over a Facility*. The intermediate segment starts 15 NM from the facility at a width of 6 NM each side of the inbound course and connects to the width of the final segment at the FAF. The area considered for obstacle clearance is from the start of the PT distance to the FAF.

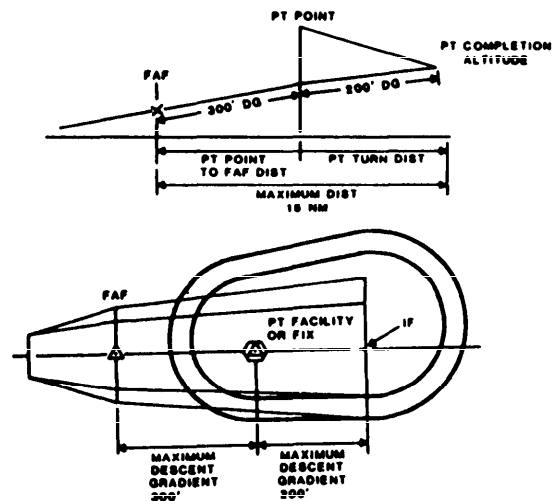


Figure 14A. INTERMEDIATE AREA WITHIN PROCEDURE TURN AREA. PT Facility/Fix Used as a Stepdown Fix. Par 244d(4).

(b) *PT Over a Fix (NOT a Facility)*. The intermediate segment starts at the PT distance at a width of 6 NM each side of the inbound course and connects to the width of the final segment at the FAF. The area considered for obstacle clearance is from the start of the PT distance to the FAF.

(4) The MAXIMUM descent gradient is 200 feet/NM. If the PT facility/fix is a stepdown fix, the descent gradient from the stepdown fix to

* the FAF may be increased to a maximum of 300 feet/NM (see Figure 14A). The PT distance may be increased in 1 NM increments up to 15 NM to meet descent limitations.

e. *PT Facility/Fix Used as an Intermediate Fix (IF).* See Figure 14B.

(1) When the PT inbound course is the same as the intermediate course, either paragraph 244d may be used, or a straight initial segment may be used from the start of the PT distance to the PT fix.

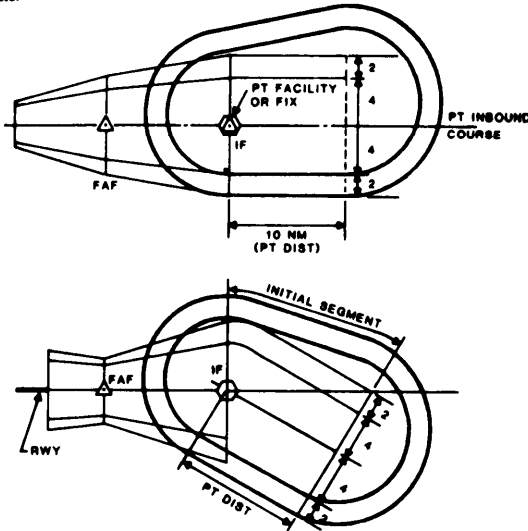


Figure 14B. USE OF PT FIX FOR IF. Par 244e.

(2) When the PT inbound course is NOT the same as the intermediate course, an intermediate segment within the PT area is NOT authorized; ONLY a straight initial segment shall be used from the start of the PT distance to the PT fix.

(3) When a straight initial segment is used, the MAXIMUM descent gradient within the PT distance is 300 feet/NM, the PT distance may be increased in 1 NM increments up to 15 NM to meet descent limitations.

f. When a PT from a facility is required to intercept a localizer course, the PT facility is considered on the localizer course when it is located within the commissioned localizer course width.

245-249. RESERVED.

Section 5. Final Approach

250. FINAL APPROACH SEGMENT. This is the segment in which alignment and descent for landing are accomplished. The final approach segment considered for obstacle clearance begins at the final approach fix or point and ends at the runway or missed approach point, whichever is encountered last. A visual portion within the final approach segment may be included for straight-in nonprecision approaches. (See Paragraph 251.). Final approach may be made to a runway for a straight-in landing, or to an airport for a circling approach. Since the alignment and dimensions of the non-visual portions of the final approach segment vary with the location and type of navigation facility, applicable criteria are contained in chapters designated for specific navigation facilities.

251. VISUAL PORTION OF THE FINAL APPROACH SEGMENT. The visual portion begins at the visual descent point and ends at the runway threshold. The visual descent point is a defined point on the final approach course of a nonprecision straight-in approach procedure from which normal descent from the MDA to the runway touchdown point may be commenced, provided visual reference is established.

a. *Visual Descent Point (VDP).* When an instrument approach procedure incorporates a VDP, the VDP shall be identified by an approved navigational fix. The fix error shall meet the fix accuracy requirements specified in Chapter 2 of this handbook, but in no case shall the fix error exceed ± 0.5 NM.

(1) Where VASI is installed, the VDP shall be located at the point where the lowest VASI glide slope intersects the lowest MDA.

(2) Where VASI is not installed, the VDP will be located at the point on the final approach course at the MDA where a descent gradient to the threshold of 300-400 feet per NM commences. If operational requirements dictate a 2° descent gradient, 212 FPNM may be used.

- * *b. Alignment.* The VDP area is centered on the runway centerline extended. See Figure 14C. *

Area. The VDP area is determined as follows:

(1) When VASI is installed, the area shall begin at a point abeam the downwind VASI bar and splay $\pm 10^\circ$ either side of the runway centerline

(2) When no VASI is installed, the area shall begin at a point 500 feet upwind from the runway threshold and splay $\pm 10^\circ$ either side of the runway centerline.

(3) Where the $\pm 10^\circ$ splay does not encompass the width of the runway at the threshold, the area shall begin at the threshold at a width equal to the runway width and splay 10° from the runway edges.

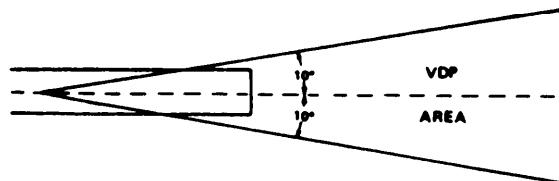
(4) The area shall terminate at the VDP or where the obstacle clearance surface elevation is equal to the MDA minus the ROC, whichever occurs first.

d. Surface. The surface is inclined upward and extends outward to the point where the VDP area terminates.

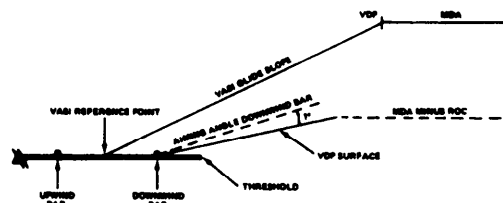
- * (1) When the VASI is installed, the surface shall extend from the downwind VASI bar at an angle 1° lower than the aiming angle of that bar. See Figure 14D. *

- * (2) When no VASI is installed, the surface shall extend from the threshold at an angle $1\frac{1}{2}^\circ$ lower than the angle resulting from the descent gradient from the VDP to the runway threshold. See Figure 14E. *

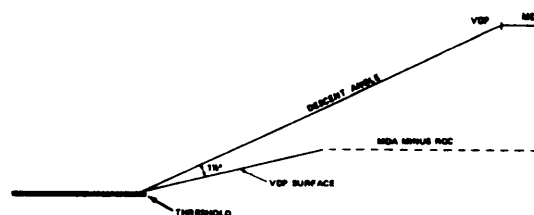
e. Obstacle Clearance. No obstacle shall penetrate the surface overlying the area associated with the VDP.



* Figure 14C. VISUAL DESCENT POINT OBSTACLE CLEARANCE SURFACE (WITH VASI's). Par 251c. *



* Figure 14D. VISUAL DESCENT POINT OBSTACLE CLEARANCE SURFACE (WITH VASI's). Par 251d(1). *



* Figure 14E. VISUAL DESCENT POINT OBSTACLE CLEARANCE SURFACE (WITHOUT VASI's). Par 251d(2). *

252. DESCENT GRADIENT. The chapters for specific navigational facilities and radio fixes used in the final approach segment contain flexible descent criteria. These specify the optimum and maximum permissible descent gradient per mile. Where a stepdown fix is used in the final approach segment the descent gradient is applicable to the areas between the FAF and the stepdown fix, and between the stepdown fix and the approach runway threshold.

253.-259. RESERVED.

Section 6. Circling Approach

260. CIRCLING APPROACH AREA. This is the obstacle clearance area which shall be considered for aircraft maneuvering to land on a runway which is not aligned with the final approach course of the approach procedure.

a. Alignment and Area. The size of the circling area varies with the approach category of the aircraft, as shown in Table 4. To define the limits of the circling area for the appropriate category, draw an arc of suitable radius from the center of the end of each usable runway. Join the extremities of the adjacent arcs with lines drawn tangent to the arcs. The area thus enclosed is the circling approach area. See Figure 15.

Table 4. CIRCLING APPROACH AREA RADII.	
Approach Category	Radius (Miles)
A	1.3
B	1.5
C	1.7
D	2.3
E	4.5

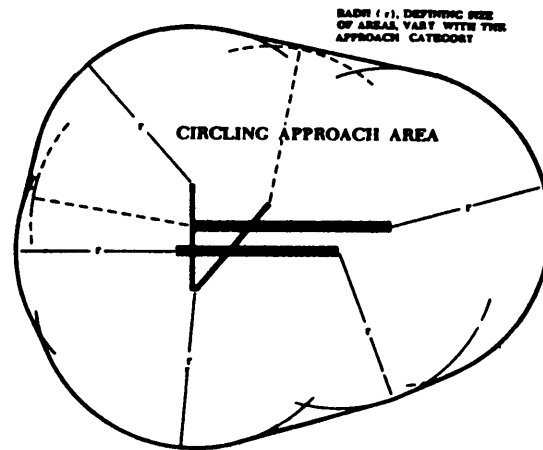


Figure 15. CONSTRUCTION OF CIRCLING APPROACH AREA. Par 260.

b. Obstacle Clearance. A minimum of 300 feet of obstacle clearance shall be provided in the circling approach area. There is no secondary obstacle clearance for the circling approach. See paragraph 322.

261. CIRCLING APPROACH AREA NOT CONSIDERED FOR OBSTACLE CLEARANCE. It will be permissible to eliminate from consideration a particular sector where prominent obstacles exist in the circling approach area, provided the landing can be made without maneuvering over this sector and further provided that a note to this effect is included in the procedure. Sectors within which circling is not permitted should be identified with runway centerlines, and where necessary, certain runway lights may be required to be operating. For example, notes might read "Circling not authorized northwest of airport between Runways 9/27 and 18/36 and night circling below MDA 700 not authorized unless Runways 9/27 and 18/36 are both lighted" or "Circling not authorized west of Runway 18/36".

262.-269. RESERVED.

Section 7. Missed Approach.

270. MISSED APPROACH SEGMENT. (See ILS and PAR chapters for special provisions). A missed approach procedure shall be established for each instrument approach procedure. The missed approach shall be initiated at the decision height in precision approaches and at a specified point in non precision approaches. The missed approach procedure must be simple, specify an altitude, and whenever practical, a clearance limit. The missed approach altitude specified in the procedure shall be sufficient to permit holding or en route flight. All alternate missed approach procedures which are to be used must be specified in the procedure.

NOTE: Only the primary missed approach procedure shall be included on the published chart.

271. MISSED APPROACH ALIGNMENT. Wherever practical, the missed approach course should be a continuation of the final approach course. Turns are permitted, but should be minimized in the interest of safety and simplicity. When a turn of no more than 15° is made, the missed approach is considered straight, and the straight missed approach area applies. See paragraph 273.

272. MISSED APPROACH POINT (MAP). The missed approach point specified in the procedure may be the point of intersection of an electronic glide path with a decision height, a navigation facility, a fix, or a specified distance from the final approach fix. The specified distance may not be more than the distance from the final approach fix to the usable landing surface. The missed approach point shall NOT be located prior to the visual descent point. See paragraph 251. Specified criteria for the MAP are contained in the appropriate facility chapters.

273. STRAIGHT MISSED APPROACH AREA. The straight missed approach area (a maximum of 15° turn from the final approach course) starts at the missed approach point. The area has a width equal to that of the final approach area at the MAP and expands uniformly to the width of the initial approach segment at a point 15 miles from the MAP. A secondary area for the reduction of obstacle clearance is identified within the missed

approach area which has the same width as the final approach secondary area at the MAP, and which expands uniformly to a width of 2 miles at a point 15 miles from the MAP. Positive course guidance is required to reduce obstacle clearance in the secondary area. See Figure 16.

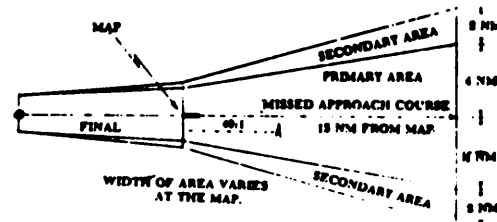


Figure 16. STRAIGHT MISSED APPROACH AREA.
Par 273.

274. STRAIGHT MISSED APPROACH OBSTACLE CLEARANCE. Within the primary missed approach area, no obstacle shall penetrate the missed approach surface. This surface begins over the missed approach point at a height determined by subtracting the required final approach obstacle clearance and any minimums adjustments, per paragraphs 287c(3) and 323 from the minimum descent altitude. It ascends uniformly at the rate of 1 foot vertically for each 40 feet horizontally (40:1). See Figure 17. Where the 40:1 surface reaches a height of 1,000 feet below the missed approach altitude (paragraph 270), further application of the surface is not required. In the secondary area, no obstacle may penetrate a 12:1 slope which extends outward and upward from the 40:1 surface at the inner boundaries of the secondary area. See Figure 18.

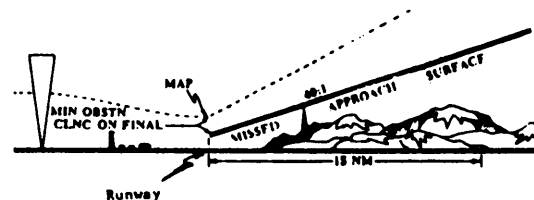


Figure 17. STRAIGHT MISSED APPROACH OBSTACLE CLEARANCE. Par 274.

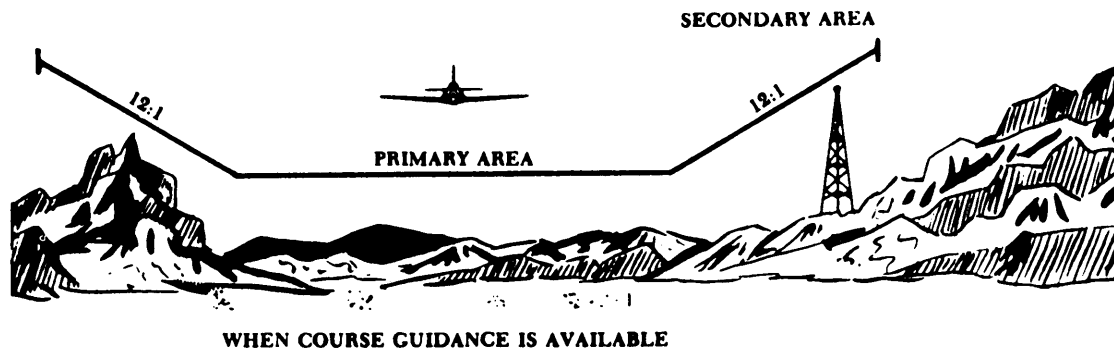


Figure 18. MISSED APPROACH CROSS SECTION. Par. 274.

275. TURNING MISSED APPROACH AREA.

(See ILS and PAR chapters for special provisions). If a turn of more than 15 degrees from the final approach course is required, a turning missed approach must be constructed. The dimensions and shape of this area are affected by three variables:

Width of final approach area at the MAP. (It is narrow close to the facility and wider farther away).

All categories of aircraft authorized to use the procedure.

Number of degrees of turn required by the procedure.

Secondary areas for the reduction of obstacle clearance are permitted when positive course guidance is provided. The secondary area begins where a line perpendicular to the straight flight path, originating at the point of completion of the turn, intersects the outer boundaries of the missed approach segment. The width of the secondary area expands uniformly from zero to 2 miles at the end of the missed approach segment. Figures 19, 20, 21, 22, 23, and 24 show the manner of construction of some typical turning missed approach areas. The following radii are used in the construction of these areas:

a. 90 Degree Turn or Less. Narrow final approach area at MAP. See Figure 19. To construct the area:

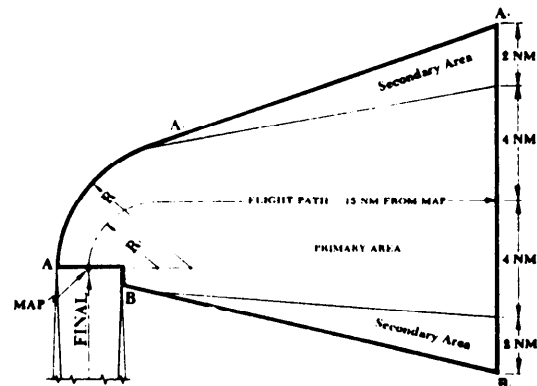


Figure 19. TURNING MISSED APPROACH AREA. 90 Degree Turn or Less. Narrow Final Approach Area at MAP. Par 275.a.

(1) Draw an arc with the radius (R_1) from the MAP. This line is then extended outward to a point 15 miles from the MAP measured along the line. This is the assumed flight path.

Table 5. TURNING MISSED APPROACH RADII (Miles).

Approach Category	Obstacle Clearance Radius (R)	Flight Path Radius (R_1)
A	2.6	1.30
B	2.8	1.40
C	3.0	1.50
D	3.5	1.75
E	5.0	2.50

(2) Establish points "A₂" and "B₁" by measuring 6 miles perpendicular to the flight path at the 15 mile point.

(3) Now connect "A₂" and "B₁" with a straight line.

(4) Draw an arc with the radius (R) from point "A" to "A₁". This is the edge of the obstacle clearance area.

(5) Establish point "B" by measuring backward on the edge of the final approach area a distance of 1 mile or a distance equal to the fix error PRIOR to the FAF, whichever is greater.

(6) Connect points "A₁," and "A₂," and points "B" and "B₁" with straight lines.

b. 90° Turn or Less. Wide final approach area at MAP. See Figure 20. To construct the area:

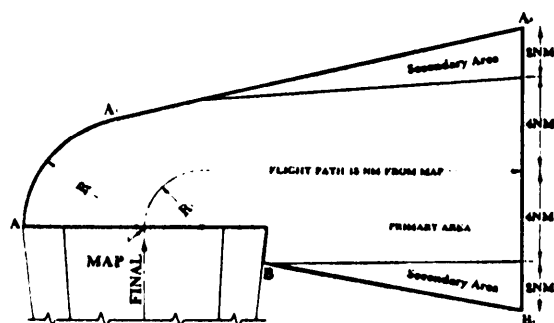


Figure 20. TURNING, MISSED APPROACH AREA, 90 Degree Turn or Less, Wide Final Approach Area at MAP, Par 275.b.

(1) Draw an arc with the appropriate radius (R_1) from the MAP. This line is then extended outward to a point 15 miles from the MAP, measured along the line. This is the assumed flight path.

(2) Establish points "A₂" and "B₁" by measuring 6 miles perpendicular to the flight path at the 15 mile point.

(3) Now connect points "A₂" and "B₁" with a straight line.

(4) Draw an arc with the appropriate radius (R) from point "A" to point "A₁". This is the edge of the obstacle clearance area.

(5) Establish point "B" by measuring backward on the edge of the final approach area a distance of 1 mile or a distance equal to the fix error PRIOR to the FAF, whichever is greater.

(6) Connect points “A₁” and “A₂”, and points “B” and “B₁” with straight lines.

c. *More Than 90° Turn. Narrow final approach area at MAP.* See Figure 21. To construct the area:

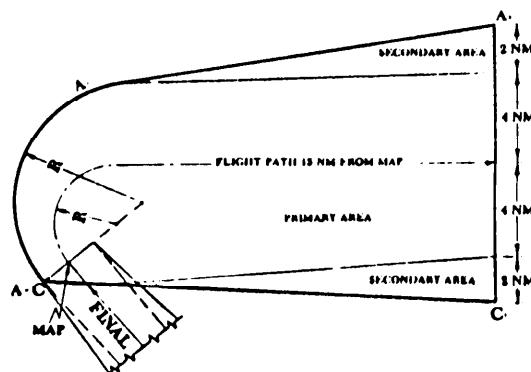


Figure 21. TURNING MISSED APPROACH AREA. More than 90 Degree Turn. Narrow Final Approach Area at the MAP. Par 275.c.

(1) Draw an arc with the radius (R_1) from the MAP through the required number of degrees and then continue outward to a point 15 miles from the MAP, measured along this line, which is the assumed flight path.

(2) Establish points "A₂" and "C₁" by measuring 6 miles on each side of the assumed flight path and perpendicular to it at the 15 mile point.

(3) Now connect points "A₂" and "C₁" with a straight line.

(4) Draw an arc with the radius (R) from point "A" to point "A₁" (Figure 21 uses 135 degrees). This is the outer edge of the obstacle clearance area.

(5) Locate point "C" at the inner edge of the final approach secondary area opposite the MAP. (Point "A" and point "C" will be coincident when the MAP is the facility).

(6) Connect points "A₁" and "A₂" and points "C" and "C₁" with straight lines.

d. More than 90 Degree Turn. Wide final approach area at MAP. See Figure 22. To construct the area:

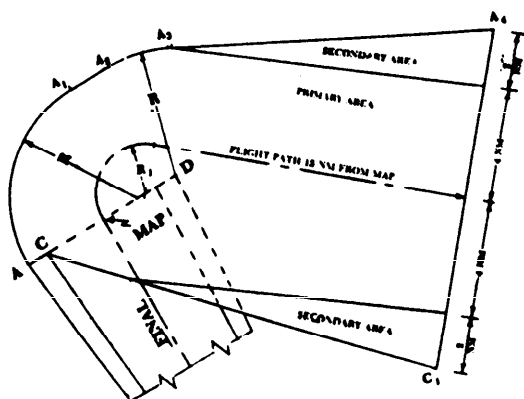


Figure 22. TURNING MISSED APPROACH AREA. More Than 90 Degree Turn. Wide Final Approach at MAP. Par 275.d.

(1) Draw the flight path arc with radius (R₁) from the MAP, and then continue the line outward to a point 15 miles from the MAP, measured along the assumed flight path.

(2) Establish points "A₄" and "C₁" by measuring 6 miles on each side of the flight path and perpendicular to it at the 15 mile point.

(3) Now connect points "A₄" and "C₁" with a straight line.

(4) Draw a 90 degree arc with the appropriate radius (R) from point "A" to point "A₁". Note that when the width of the final approach area at the MAP is greater than the appropriate radius (R), the turn is made in two increments when constructing the obstacle clearance area.

(5) Draw an arc with the radius (R) from point "D" (edge of final approach secondary area opposite MAP) the required number of degrees from point "A₂" to point "A₃". Compute the number of degrees by subtracting 90 from the total turn magnitude.

(6) Connect points "A₁" and "A₂" with a straight line.

(7) Locate point "C" at the inner edge of the final approach secondary area opposite the MAP.

(8) Connect point "A₃" with point "A₄", and connect point "C" with point "C₁" using straight lines.

e. 180 Degree Turn. Narrow final approach area at MAP. See Figure 23. To construct the area:

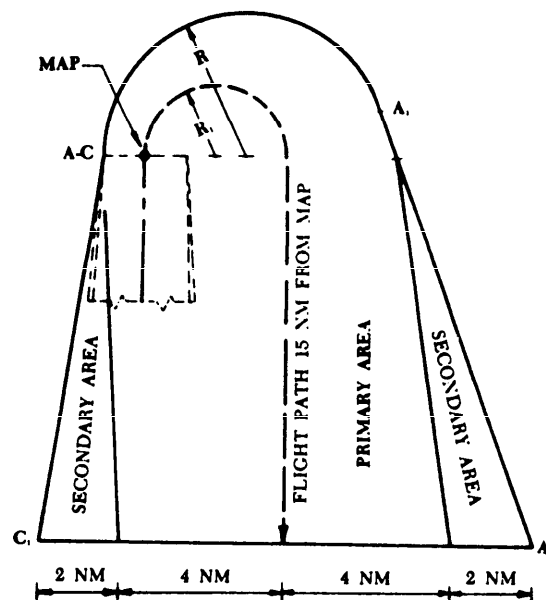


Figure 23. TURNING MISSED APPROACH AREA. 180 Degree Turn. Narrow Final Approach Area at MAP. Par 275.e.

(1) Draw an arc with the radius (R_1) from the MAP through 180 degrees, and then continue outward to a point 15 miles from the MAP, measured along this line, which is the assumed flight path.

(2) Establish points " A_2 " and " C_1 " by measuring 6 miles on each side of the assumed flight path, and perpendicular to it at the 15 mile point.

(3) Now connect point " A_2 " and point " C_1 " with a straight line.

(4) Locate point " C " at the inner edge of the final approach secondary area opposite the MAP. (Point " A " and point " C " will be coincident when the MAP is the facility.)

(5) Draw an arc with the radius (R) from point " A " to point " A_1 " (180 degrees). This is the outer edge of the obstacle clearance area.

(6) Connect points " A_1 " and " A_2 ", and points " C " and " C_1 " by straight lines. (The line " A_1-A_2 " joins the arc tangentially.)

f. 180 Degree Turn. Wide final approach area at MAP. See Figure 24. To construct the area:

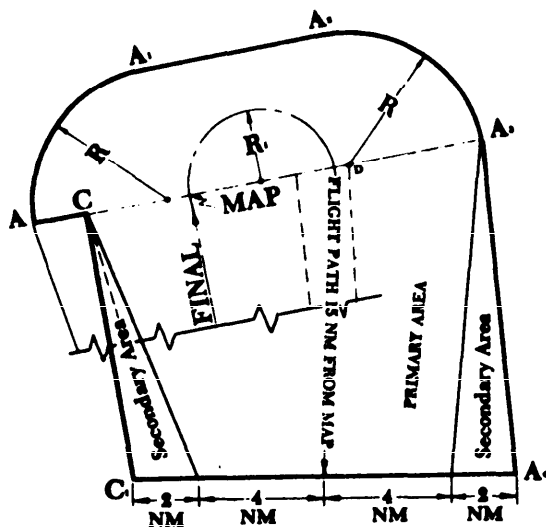


Figure 24. TURNING MISSED APPROACH AREA, 180 Degree Turn. Wide Final Approach Area at MAP. Par 275.f.

(1) Draw the assumed flight path arc with the radius (R_1) from the MAP the required number of degrees to the desired flight path or course.

(2) Establish points " A_4 " and " C_1 " by measuring 6 miles on each side of the assumed flight path and perpendicular to it at the 15 mile point.

(3) Connect points " A_4 " and " C_1 " with straight lines.

(4) Draw a 90 degree arc with the appropriate radius (R) from point " A " to point " A_1 ". Note that when the width of the final approach area at the MAP is greater than the appropriate radius (R) the turn is made in two increments when constructing the obstacle clearance area.

(5) Draw an arc with the radius (R) from point " D " (edge of final approach area opposite MAP) the required number of degrees from point " A_2 " to point " A_3 ". Compute the number of degrees by subtracting 90 degrees from the total turn magnitude.

(6) Connect points " A_1 " and " A_2 " with a straight line.

(7) Locate point " C " at the inner edge of the final approach secondary area opposite the MAP.

(8) Connect points " A_3 " and " A_4 " and points " C " and " C_1 " with straight lines. (The line " A_3-A_4 " joins the arc tangentially.)

276. TURNING MISSED APPROACH OBSTACLE CLEARANCE. The methods of determining the height of the 40:1 missed approach surface over

obstacles in the turning missed approach area vary with the amount of turn involved.

a. 90° Turn or Less. See Figure 25. Zone 1 is a 1.6 mile continuation of the final approach secondary area, and has identical obstacle clearance requirements. Zone 2 is the area in which the height of the missed approach surface over an obstacle must be determined. To do this, first identify line "A-D-B". Point "B" is located by measuring backward on the edge of the final approach area a distance of 1 mile or a distance equal to the fix error prior to the FAF, whichever is greater. This is to safeguard the short-turning aircraft. Thus the height of the missed approach surface over an obstacle in Zone 2 is determined by measuring the straight-line distance from the obstacle to the nearest point on line "A-D-B" and computing the height based on the 40:1 ratio. The height of the missed approach surface over the MAP is the same as specified in paragraph 274. When an obstacle is in a secondary area, measure the straight-line distance from the nearest point on the line "A-D-B" to the point on the inner edge of the secondary area which is nearest the obstacle. Compute the height of the missed approach surface at this point, using the 40:1 ratio. Then apply the 12:1 secondary area ratio from the height of the surface for the remaining distance to the obstacle.

b. More Than 90° Turn. See Figure 26. In this case a third Zone becomes necessary. Zone 3 is defined by extending a line from point "B" to the extremity of the missed approach area perpendicular to the final approach course.

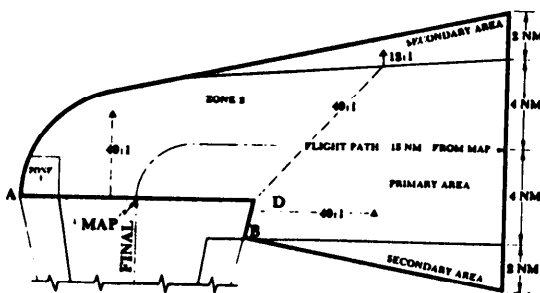


Figure 25. TURNING MISSED APPROACH OBSTACLE CLEARANCE, 90 Degree Turn or Less.

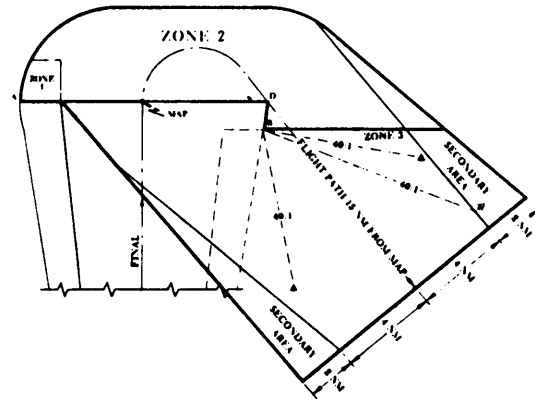


Figure 26. TURNING MISSED APPROACH OBSTACLE CLEARANCE, More Than a 90 Degree Turn. Par 276.b.

Zone 3 will encompass all of the missed approach area not specifically within Zones 1 and 2. All distance measurements in Zone 3 are made from point "B". Thus the height of the missed approach surface over an obstacle in Zone 3 is determined by measuring the distance from the obstacle to point "B" and computing the height based on the 40:1 ratio. The height of the missed approach surface over point "B" for Zone 3 computations is the same as the height of the MDA. For an obstacle in the secondary area, use the same measuring method prescribed in paragraph 276a, except that the original measuring point shall be point "B".

c. Secondary Area. In the secondary area no obstacles may penetrate a 12:1 slope which extends outward and upward from the 40:1 surface from the inner to the outer boundary lines of the secondary area.

277. COMBINATION STRAIGHT AND TURNING MISSED APPROACH AREA. If a straight climb to a specific altitude followed by a turn is necessary to avoid obstacles, a combination straight and turning missed approach area must be constructed. The straight portion of this missed approach area is Section 1. The portion in which the turn is made is Section 2.

a. Straight Portion. Section 1 is a portion of the normal straight missed approach area and is constructed as specified in paragraph 273. Obstacle clearance is provided as specified in paragraph 274 except that secondary area reductions do not apply.

The length of Section 1 is determined as shown in Figure 27 and relates to the need to climb to a specified altitude prior to commencing the turn. Point A₁ marks the end of Section 1. Point B₁ is one mile from the end of Section 1. (See Figure 27).

b. Turning Portion. Section 2 is constructed as specified in paragraph 275 except that it begins at

the end of Section 1 instead of at the MAP. To determine the height which must be attained before commencing the missed approach turn, first identify the controlling obstacle on the side of Section 1 to which the turn is to be made. Then measure the distance from this obstacle to the nearest edge of the Section 1 area. Using this distance as illustrated in Figure 27, determine the height of the 40:1 slope at

EXAMPLE

Given:

1. MDA 360' MSL
2. Obstacle height: 1098' MSL
3. Obstacle in section 2 = 3NM from near edge of section

Find:

1. Minimum altitude at which aircraft can start turn.
2. Required length of section 1.

Solution:

1. Find height MSL at near edge.
 - a. $A = 18,228' (3 \text{ mi}) \div 40 = 456'$.
 - b. $1098' \text{ MSL} - 456' = 642' \text{ MSL}$.

2. Add 250' obstacle clearance.
 - a. $250' + 642' = 892' \text{ MSL}$.
3. Round up to next higher 20'.
 - a. $892' = 900' \text{ MSL}$ to start turn.
4. Find height to climb from MDA to 900' MSL.
 - a. $900' - 360' = 540'$ to climb.
5. Find length of section 1.
 - a. $540' \times 40 = 21,600'$ — length of section 1.
6. Missed approach instructions.
 - a. "Climb to 900' before starting right turn to, etc."

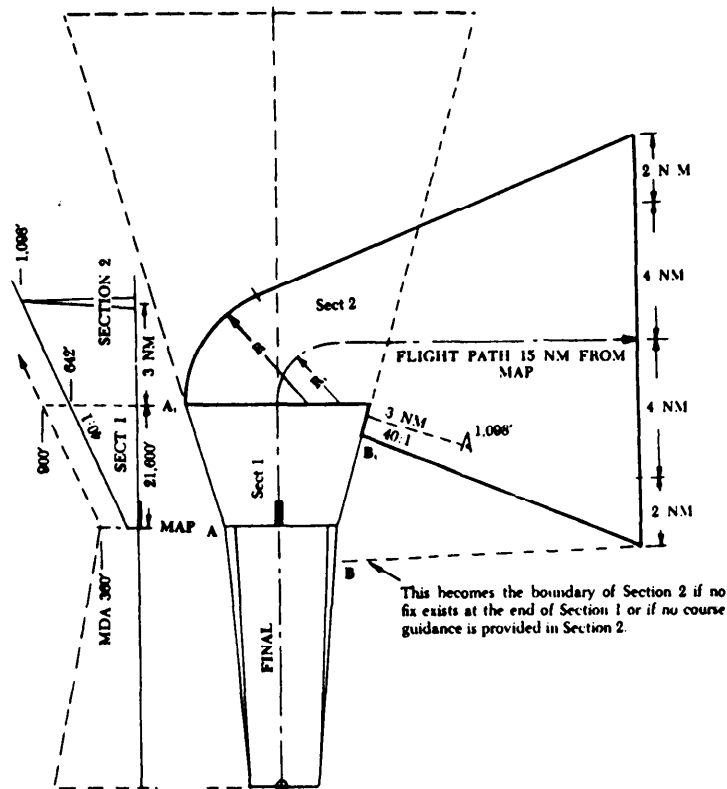


Figure 27. COMBINATION MISSED APPROACH AREA, Par. 277.

the edge of Section 1. This height plus 250 feet (rounded off to the next higher 20-foot increment) is the height at which the turn should be started. Obstacle clearance requirements in Section 2 are the same as those specified in paragraph 276 except that Zone 1 is not considered and Section 2 is expanded to start at Point B if no fix exists at the end of Section 1 or if no course guidance is provided in Section 2. See Figure 27.

278. END OF MISSED APPROACH. Aircraft shall be assumed to be in the initial approach or en route environment upon reaching minimum obstacle clearance altitude (MOCA) or minimum en route altitude (MEA). Thereafter, the initial approach or the en route clearance criteria apply.

279. RESERVED.

Section 8. Terminal Area Fixes

280. GENERAL. Terminal area fixes include, but are not limited to the Final Approach Fix (FAF), the Intermediate Fix (IF), the Initial Approach Fix (IAF), the holding fix, and when possible, a fix to mark the missed approach point. Each fix is a geographical position on a defined course. Terminal area fixes should be based on similar navigation systems. For example, TACAN, VORTAC, and VOR/DME facilities provide Radial/DME fixes. NDB facilities provide bearings. VOR facilities provide VOR radial. The use of integrated (VHF/NDB) fixes shall be limited to those intersection fixes where no satisfactory alternative exists.

281. FIXES FORMED BY INTERSECTION. A geographical position can be determined by the intersection of course or radials from two stations. One station provides the course the aircraft is flying and the other provides a crossing indication which identifies a point along the course which is being flown. Because all stations have accuracy limitations, the geographical point which is identified is not precise, but may be anywhere within a quadrangle which surrounds the plotted point of intersection. Figure 28 illustrates the intersection of an arc and a radial from the same DME facility and the intersection of two radials or courses from different navigation facilities. The area encompassed by the sides of the quadrangle formed in these ways is referred to in this publication as the "fix displacement area."

282. DME FIXES. A DME fix is formed by a DME reading on a positive navigational course. The information should be derived from a single facility with collocated azimuth and DME antennas. However, when a unique operational requirement indicates a need for DME information from other than collocated facilities, an individual instrument approach procedure which specifies DME may be approved, provided the angular divergence between the signal sources at the fix does not exceed 23°. See Figure 28. For limitation on use of DME with ILS, see paragraph 912.

*** 283. FIXES FORMED BY RADAR.** Where ATC can provide the service, Airport Surveillance Radar (ASR) may be used for any terminal area fix. Precision Approach Radar (PAR) may be used to form any fix within the radar coverage of the PAR system. Air Route Surveillance Radar (ARSR) may be used for initial approach and intermediate approach fixes. *

284. FIX DISPLACEMENT AREA. The areas portrayed in Figure 28 extend along the flight course from point "A" to point "C". The fix error is a plus-or-minus value, and is represented by the lengths from "A" to "B" and "B" to "C". Each of these lengths is applied differently. The fix error may cause the fix to be received early (between "B" and "C"). Because the fix may be received early, protection against obstacles must be provided from a line perpendicular to the flight course at point "A".

285. INTERSECTION FIX DISPLACEMENT FACTORS. The intersection fix displacement area is determined by the system use accuracy of the navigation fixing systems. The system use accuracy in VOR and TACAN type systems is determined by the combination of ground station error, airborne receiving system error, and pilotage error. Long experience in en route use of VOR has shown that a VOR system use accuracy along radial courses of plus-or-minus 4.5°, 95% of occasions, is a realistic, conservative figure. Thus, in normal use of VOR or TACAN intersections, fix displacement factors may conservatively be assessed as follows:

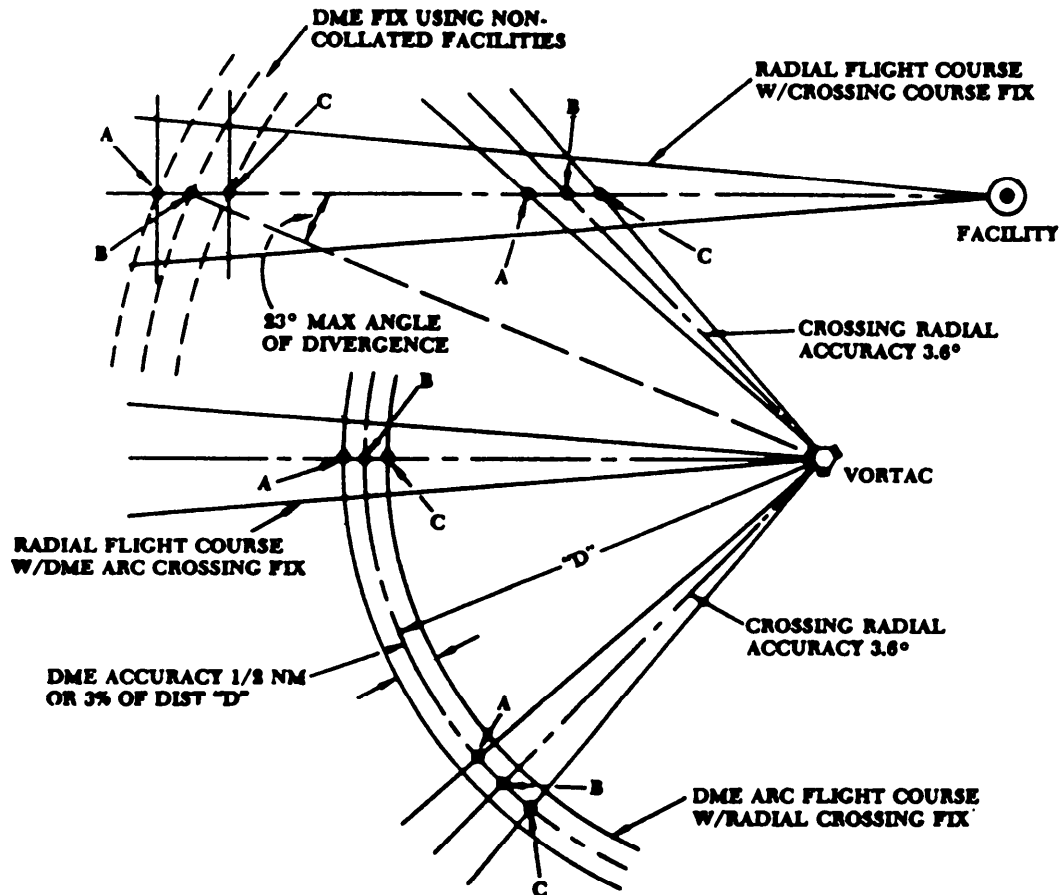


Figure 28. INTERSECTION FIX DISPLACEMENT. Par 281, 282, 283.

a. Along-Course Accuracy.

- (1) VOR/TACAN radials, plus-or-minus 4.5 degrees.
- (2) Localizer course, plus-or-minus 1 degree.
- * (3) NDB courses or bearing, plus-or-minus 5 degrees. *

NOTE: The plus-or-minus 4.5-degree (95 percent) VOR/TACAN figure is achieved when the ground station course signal error, the pilotage error, and the VOR airborne equipment error are controlled to certain normal tolerances. Where it can be shown that any of the three error elements is consistently different from these assumptions (for example, if flight inspection shows a consistently better VOR signal accuracy or stability than the one assumed, or if it can be shown that airborne equipment error is consistently smaller than assumed), VOR fix displacement factors smaller than those shown above may be utilized in accordance with paragraph 141.

b. Crossing Course Accuracy.

- (1) VOR/TACAN radials, plus-or-minus 3.6° *
- (2) Localizer course, plus-or-minus 0.5° *
- (3) NDB bearings, plus-or-minus 5°.

NOTE: The plus-or-minus 3.6 degree (95 percent) VOR/TACAN figure is achieved when ground station course signal error and the VOR airborne equipment error are controlled to certain normal tolerances. Since the crossing course is not flown, pilotage error is not a contributing element. Where it can be shown that either of the error elements is consistently different, VOR displacement factors smaller than those shown above may be utilized in accordance with paragraph 141.

286. OTHER FIX DISPLACEMENT FACTORS.

a. Radar. Plus-or-minus 500 feet or 3% of the distance to the antenna, whichever is greater.

b. DME. Plus-or-minus 1/2 (0.5) miles or 3 percent of the distance to the antenna, whichever is greater.

c. 75 mhz Marker Beacon.

- (1) Normal powered fan marker, plus-or-minus 2 miles.
- (2) Bone-shaped fan marker, plus-or-minus 1 mile.
- (3) Low powered fan marker, plus-or-minus 1/2 mile.
- (4) "Z"-marker, plus-or-minus 1/2 mile.

NOTE: Where these 75 MHz marker values are restrictive, the actual coverage of the fan marker (2 milliamp signal level) at the specific location and altitude may be used instead.

d. Overheading a Station. The fix error involved in station passage is not considered significant in terminal applications. The fix is therefore considered to be at the plotted position of the navigation facility. The use of TACAN station passage as a fix is NOT acceptable for holding fixes or high altitude initial approach fixes.

287. SATISFACTORY FIXES.

a. Intermediate or Initial Approach Fix. To be satisfactory as an intermediate or initial approach fix, the fix error must not be larger than 50 percent of the appropriate intermediate or initial segment distance which follows the fix. Measurements are made from the plotted fix position. See Figure 29.

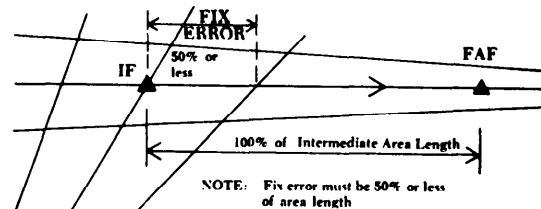


Figure 29. INTERMEDIATE OR INITIAL APPROACH FIX ERRORS. Par 287.

b. Holding Fixes. Any terminal area fix except overheading a TACAN may be used for holding, except that if the fix is an intersection formed by courses or radials the following conditions shall exist:

- (1) The angle of divergence of the intersecting courses or radials shall not be less than 45°
- (2) If the facility which provides the crossing courses is NOT an NDB, it may be as much as 45 miles from the point of intersection.
- (3) If the facility which provides the crossing course is an NDB, it must be within 30 miles of the intersection point.
- (4) If distances stated in 287b(2) or (3) are exceeded, the minimum angle of divergence of the intersecting courses must be increased at the following rate:
 - (a) If an NDB facility is involved, 1° for each mile over 30 miles.
 - (b) If an NDB facility is NOT involved, 1/2° for each mile over 45 miles.

For example, if the intersection is formed by radials from VOR's 30 and 45 miles away, the minimum angle is 45°. If one of the facilities is NDB, the minimum angle is 60°. See Figure 30.

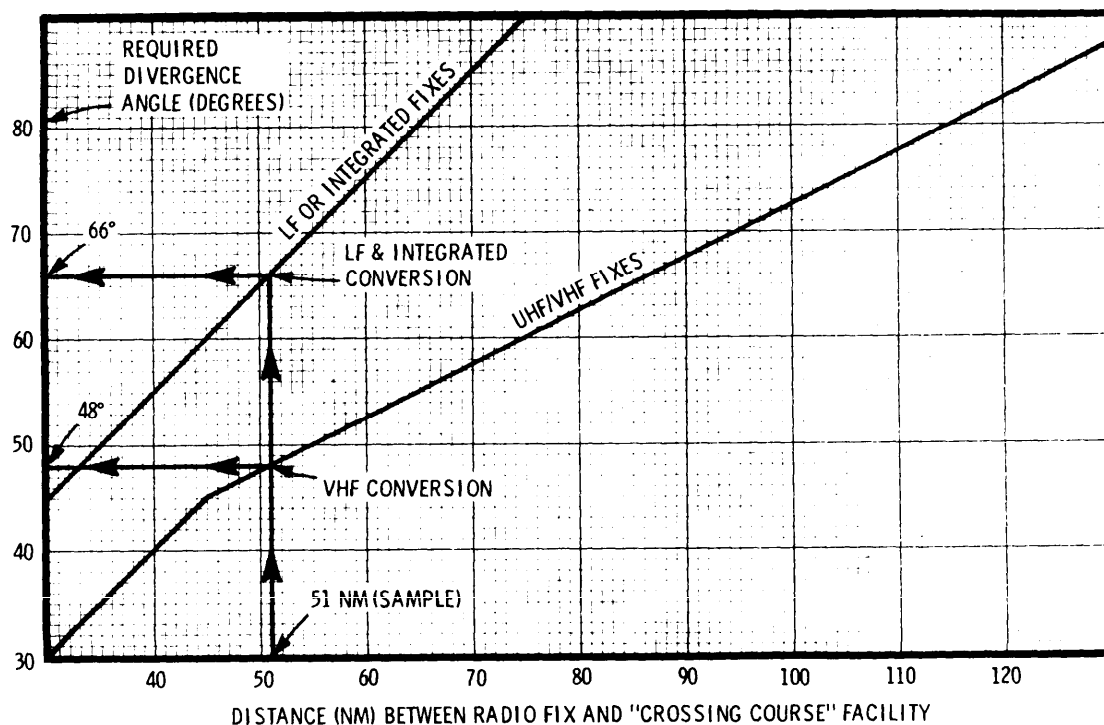


Figure 30. MINIMUM DIVERGENCE ANGLE FOR HOLDING FIXES. Par 287.b.

c. *Final Approach Fix (FAF).* For a fix to be satisfactory for use as a final approach fix, the fix error shall not exceed plus-or-minus 1 mile (see Figure 31), except that it may be as large as plus-or-minus 2 miles when:

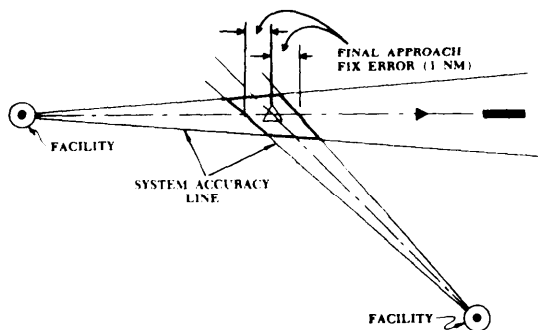


Figure 31. MEASUREMENT OF FINAL APPROACH FIX ERROR. Par 287.c.

(1) The missed approach point is marked by overheading an air navigation facility (except 75 mhz markers); OR

(2) A buffer of equal length to the excessive fix error is provided between the published missed approach point and the point where the missed approach surface begins (see Figure 32); OR

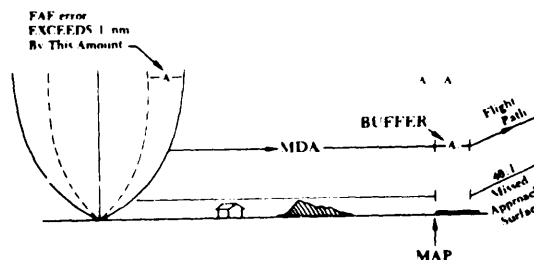


Figure 32. FINAL APPROACH FIX ERROR BUFFER. Par 287.c.(2)

(3) The minimum descent altitude is raised at a rate of 15 feet per one-tenth mile of excessive fix error; OR

(4) A combination of the actions in (2) and (3) above will adjust the missed approach surface to compensate for excessive fix error.

288. USING FIXES FOR DESCENT.

a. *Distance Available for Descent.* When applying descent gradient criteria applicable to an approach segment (initial, intermediate or final approach areas), the measuring point is the plotted position of the fix. See Figure 33.

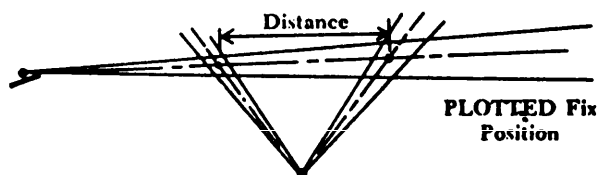


Figure 33. DISTANCE FOR DESCENT GRADIENT APPLICATION. Par 288.a.

b. *Obstacle Clearance After Passing a Fix.* It is assumed that descent will begin at the earliest point the fix can be received. Full obstacle clearance shall be provided from this point to the plotted point of the next fix. Therefore, the altitude to which descent is to be made at the fix must provide the same clearance over obstacles in the fix displacement area as it does over those in the approach segment which is being entered. See Figures 34 and 34A.

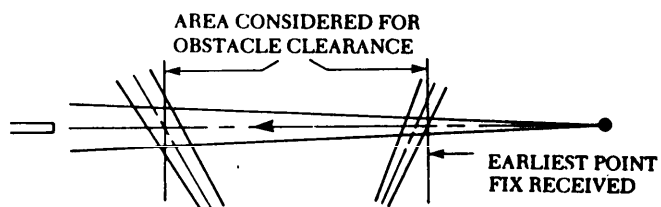


Figure 34. OBSTACLE CLEARANCE AREA BETWEEN FIXES. Par 288.b.

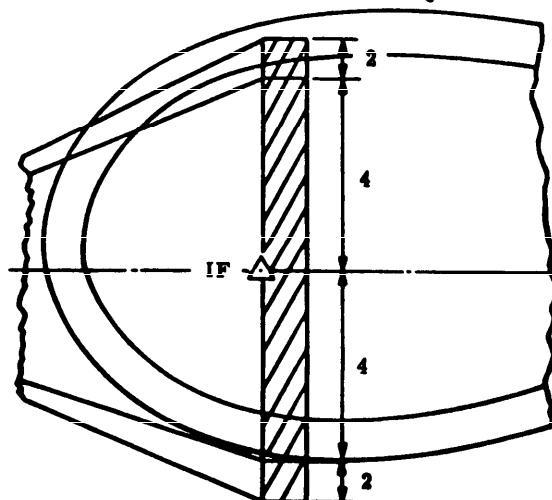
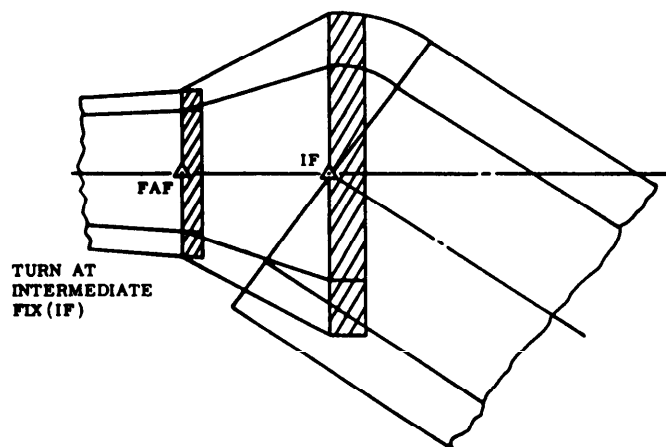
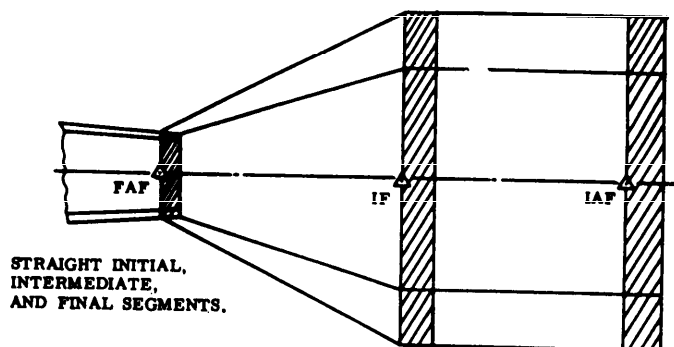


Figure 34A. CONSTRUCTION OF FIX DISPLACEMENT AREA FOR OBSTACLE CLEARANCE. PAR 288.b.

*

c. Stepdown Fixes. See Figure 35.

(1) **DME or Radar Fixes.** There is no maximum number of stepdown fixes in any segment when DME or radar is used. Multiple fixes shall be in whole NM increments.

(2) **Intersection Fixes.**

(a) Only one stepdown fix is permitted in the final and intermediate segments.

(b) If an intersection fix forms an FAF, IF, or IAF:

1 The same crossing facility shall be used for the stepdown fix(es) within that segment.

2 All fixes from the IF to the last stepdown fix in final shall be formed using the same crossing facility.

(c) Table 5A shall be used to determine the number of stepdown fixes permitted in the initial segment. Multiple fixes shall be in whole NM increments.

(3) **Altitude at the Fix.** The minimum altitude at each stepdown fix shall be specified in 100-foot increments, except the altitude at the last stepdown fix in the final segment may be specified in a 20-foot increment.

(4) **In the Final Segment:**

(a) A stepdown fix shall not be established unless a decrease of at least 60 feet in MDA or a reduction in visibility minimums is achieved.

(b) The last stepdown fix error shall not exceed ± 2 NM. When the fix error exceeds ± 1 NM, see paragraph 287c. The fix error for other stepdown fixes in final shall not exceed 1 NM.

(c) Minimums shall be published both with and without the last stepdown fix, except for procedures requiring DME or NDB procedures which use a VOR radial to define the stepdown fix.

*

Table 5A. Stepdown Fixes in Initial Segment

Length of Segment	Number of Fixes
5-10 NM	1 stepdown fix
over 10-15 NM	2 stepdown fixes
over 15 NM	3 stepdown fixes

289. OBSTACLES CLOSE TO A FINAL APPROACH OR STEPDOWN FIX. Existing obstacles located in the final approach area within 1 mile past the point where a fix can first be received may be eliminated from consideration by application of a descent gradient of 1 foot vertically for every 7 feet horizontally. This 7:1 descent gradient shall begin at the point where the fix can first be received at a height determined by subtracting the required final approach obstacle clearance (ROC) from the minimum altitude required at the fix. Obstacles which receive this treatment shall be noted on the procedures. See Figure 36. To determine fix error see paragraphs 284, 285, and 286.

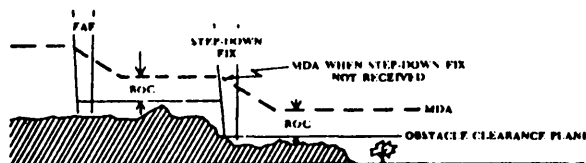


Figure 35. FINAL SEGMENT STEPDOWN FIX, par. 288c.

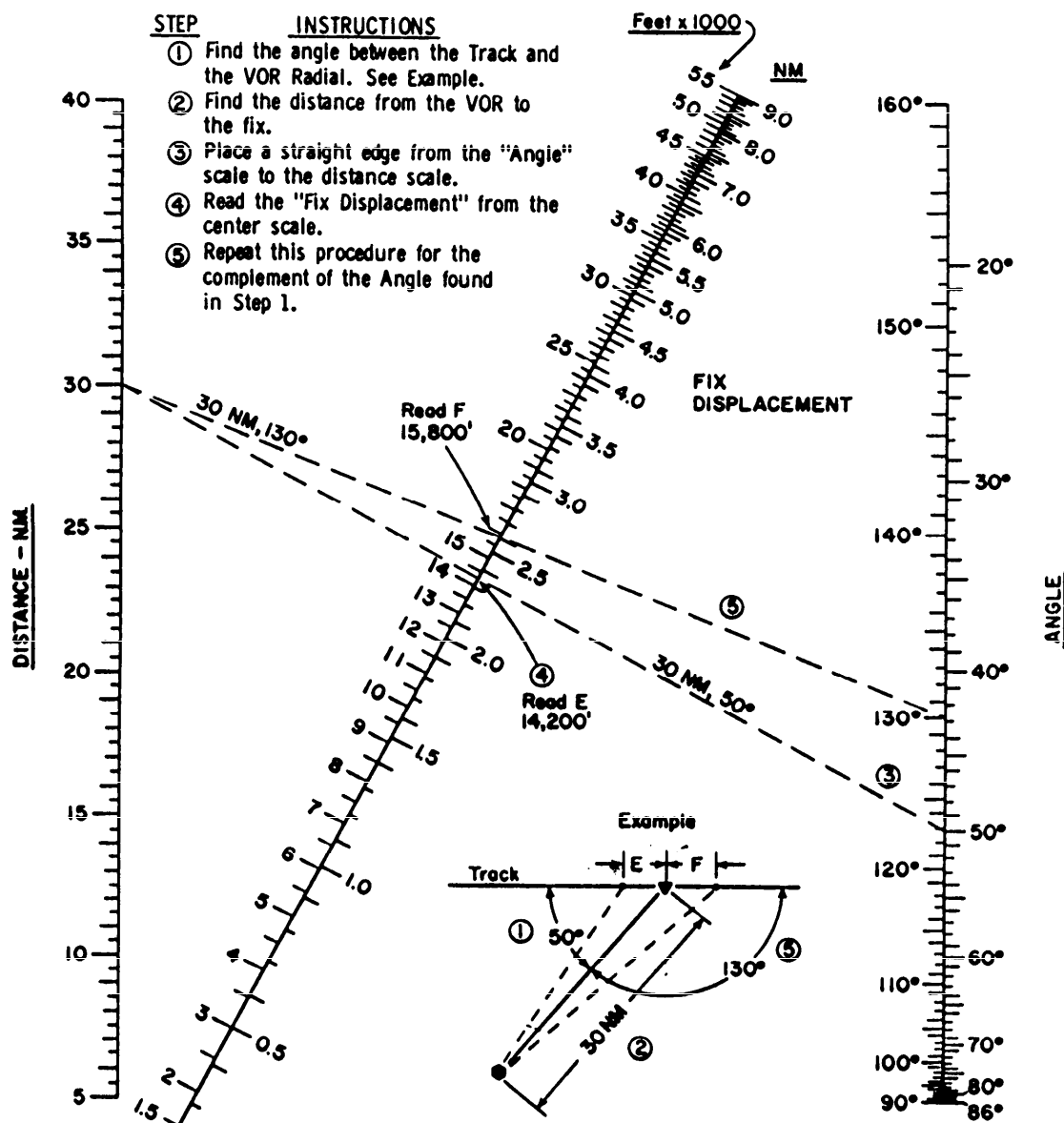
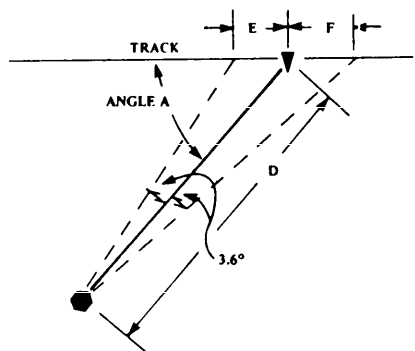


Figure 35A. FIX DISPLACEMENT NOMOGRAPH.

The 3.6° Fix Displacement Nomograph is sufficiently accurate for most applications; however, when precise values are desired the following formulas may be used:



3.6° Fix Displacement

Formula

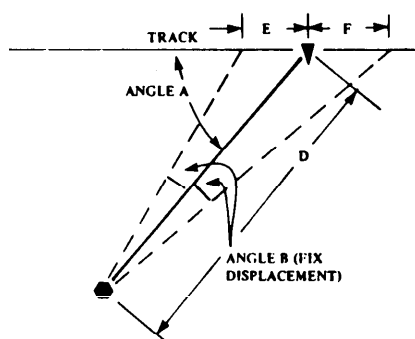
Example

$$A = 50^\circ \quad D = 30 \text{ NM}$$

$$E = \frac{381.53 \times D}{\sin(A + 3.6^\circ)} : \frac{381.53 \times 30}{\sin 53.6^\circ} = \frac{11,445.9}{.8049} = 14,220.3'$$

$$F = \frac{381.53 \times D}{\sin(A - 3.6^\circ)} : \frac{381.53 \times 30}{\sin 46.4^\circ} = \frac{11,445.9}{.7242} = 15,804.9'$$

Where: E and F are in feet, and D is in Nautical Miles.



Any Fix Displacement Error

Formula

Example

$$A = 50^\circ \quad D = 30 \text{ NM} \quad \text{Angle } B = 4.5^\circ$$

$$E = \frac{6,076.103 \times D \times \sin B}{\sin(A + B)} : \frac{6,076.103 \times 30 \times \sin 4.5^\circ}{\sin(50^\circ + 4.5^\circ)} = \frac{6,076.103 \times 30 \times .07846}{\sin 54.5^\circ} = \frac{14,301.9}{.8141} = 17,567.7'$$

$$F = \frac{6,076.103 \times D \times \sin B}{\sin(A - B)} : \frac{6,076.103 \times 30 \times \sin 4.5^\circ}{\sin(50^\circ - 4.5^\circ)} = \frac{6,076.103 \times 30 \times .07846}{\sin 45.5^\circ} = \frac{14,301.9}{.71325} = 20,051.7'$$

Where: E and F are in feet, and D is in Nautical Miles.

Figure 35B. FIX DISPLACEMENT COMPUTATIONS

Section 9. Holding

290. HOLDING PATTERNS. Criteria for holding pattern airspace are contained in FAA Handbook 7130.3, and provide for separation of aircraft from aircraft. The criteria contained herein deal with the clearance of holding aircraft from obstacles.

291. ALIGNMENT. Whenever practical, holding patterns should be aligned to coincide with the flight course to be flown after leaving the holding fix. However, when the flight path to be flown is along an arc, the holding pattern should be aligned on a radial. When a holding pattern is established at a final approach fix and a procedure turn is not used, the inbound course of the holding pattern shall be aligned to coincide with the final approach course unless the final approach fix is a facility. When the final approach fix is a facility, the inbound holding course and the final approach course shall not differ by more than 30 degrees.

* 292. AREA.

a. The primary obstacle clearance area shall be based on the appropriate holding pattern area specified in FAA Handbook 7130.3.

b. No reduction in the pattern sizes for 'on-entry' procedures is permitted.

c. Pattern number 4 is the minimum size authorized.

d. When holding is at an intersection fix, the selected pattern shall be large enough to contain at least 3 corners of the fix displacement area. See paragraphs 284 and 285 and Figure 37.

e. When paragraph 293b is used, the primary holding area shall encompass the departure or missed approach segment width at the holding fix. See Figure 37A.

f. A secondary area 2 miles wide surrounds the perimeter of the primary area.

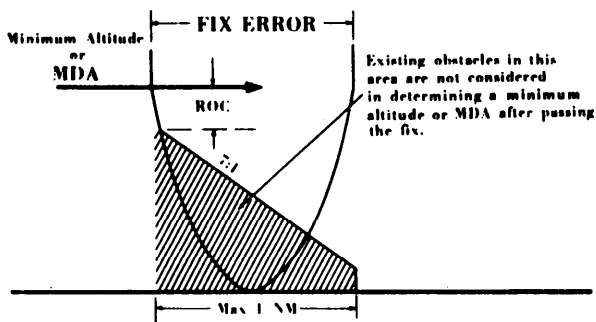


Figure 36. OBSTACLES CLOSE-IN TO A FIX. Par 289.

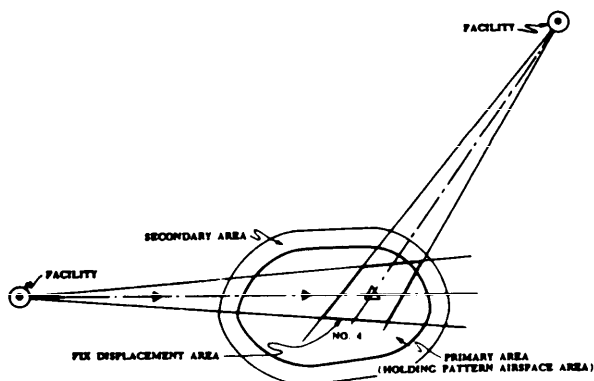


Figure 37. HOLDING PATTERN TEMPLATE APPLICATION. Par 292.

* 293. OBSTACLE CLEARANCE.

a. *Level Holding.* A minimum of 1000 feet of obstacle clearance shall be provided throughout the primary area. In the secondary area 500 feet of obstacle clearance shall be provided at the inner edge, tapering to zero feet at the outer edge. For computation of obstacle clearance in the secondary area see Appendix 2, paragraph 5 and Figure 123. Allowance for precipitous terrain should be considered as stated in paragraph 323a. The altitudes selected by application of the obstacle clearance specified in this paragraph may be rounded to the nearest 100 feet. See paragraph 231.

b. *Climbing in a Holding Pattern.* When a climb in a holding pattern is used, as in a departure or missed approach, no obstacle shall penetrate the holding surface. This surface begins at the end of the segment leading to the holding fix. Its elevation is that of the departure OIS or missed approach surface at the holding fix. It rises at a 40:1 rate to the edge of the primary area, then at a 12:1 rate to the outer edge of the secondary area. The distance to any obstacle is measured from the obstacle to the nearest point on the end of the segment at the holding fix. See Figure 37A and FAA Handbook 7130.3, paragraph 35.

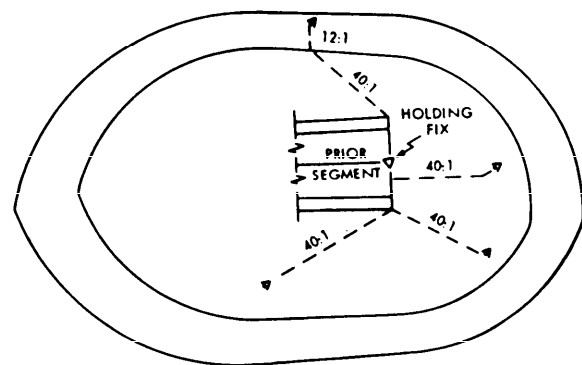


Figure 37A. CLIMBING IN A HOLDING PATTERN. Par. 293b

294. - 299. RESERVED.